MECHANICAL ENGINEERING

· SEPTEMBER 1949 ·

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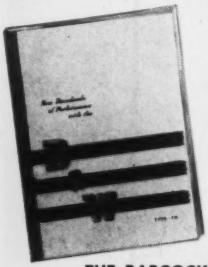

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MECHANICAL ENGINEERING

Published by The American Society of Mechanical Engineers

VOLUME 71 NUMBER 9

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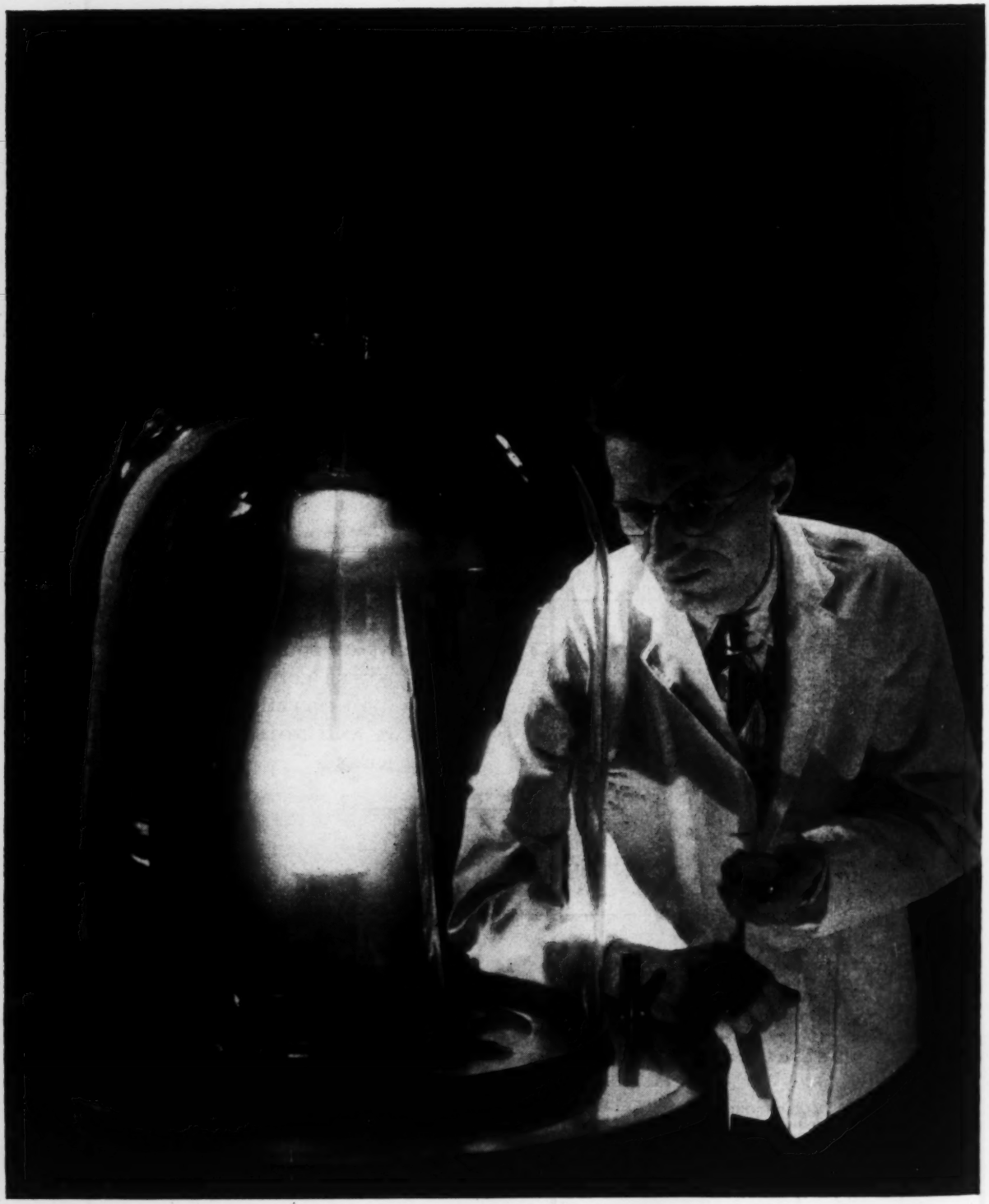
Published monthly by The American Society of Mechanical Engineers. Publication office at 20th and Northampton Streets, Easton, Pa. Editorial and Advertising departments at the headquarters of the Society, 29 West Thirty-Ninth Street, New York 18, N. Y. Cable address, "Dynamic," New York. Price 75 cents a copy, $7.00 a year; to members and affiliates, 50 cents a copy, $4.00 a year. Postage outside of the United States of America, $1.50 additional. Changes of address must be received at Society headquarters three weeks before they are to be effective on the mailing list. Please send old as well as new address. . . . By-Law: The Society shall not be reponsible for statements or opinions advanced in papers or . . . printed in its publications (B13, Par. 4) . . . . Entered as second-class matter at the Post Office at Easton, Pa., under the Act of March 3, 1879. . . . Acceptance for mailing at special rate of postage provided for in section 1103, Act of October 3, 1917, authorized on January 17, 1921. . . . Copyrighted, 1949, by The American Society of Mechanical Engineers. Member of the Audit Bureau of Circulations. Reprints from this publication may be made on condition that full credit be given MECHANICAL ENGINEERING and the author, and that date of publication be stated.

MECHANICAL ENGINEERING is indexed by the Engineering Index, Inc.



Cathodic Vacuum Etching

(A unique method of examining metal structure to determine quality and to aid in development of improved materials has been developed by the Ford Motor Company, Dearborn, Mich. It utilizes ionized atoms and is called cathodic vacuum etching. A metal sample is being tested in the company's applied physics research department. The metal is placed in a partial vacuum containing argon, a rare gas. A charge of 12,000 volts of electricity is sent into the vacuum. This creates argon ions which bombard the metal's surface, knocking off minute particles and bringing out the true microstructure of the metal with greater detail and clarity.)

VOLUME 71
No. 9

MECHANICAL ENGINEERING

SEPTEMBER
1949

GEORGE A. STETSON, *Editor*

Special-Interest Publications

IN these pages last month a contrast was drawn between conditions existing in engineering in 1880, when The American Society of Mechanical Engineers was organized, and today. It was suggested that the dearth of published material relating to mechanical engineering which existed in 1880 was a compelling reason for establishing an engineering society having as one of its objectives the preparation, discussion, and publication of technical papers. It was also stated that with the enormous growth of published engineering and scientific information by hundreds of agencies, the broadening of the fields of subject matter, the constantly increasing number of specialties in which the mechanical engineer engages, and the evolution of engineering toward an ultimate professional status, have resulted in changes in publications requirements and policies.

Examination of present-day publication problems of technical societies seems to have led to a realization that papers of permanent reference value and of specialized interest, such as appear in ASME Transactions, for example, are of the so-called archive type, destined principally for library collections where they will always be available to engineers. In general such papers are written for specialists by specialists, and hence no single paper can be expected to appeal strongly to a very large percentage of engineers at the time of presentation, although they are of unmeasured value when occasion demands their use. This apparently has led to a change in reading habits of engineers which places a greater reliance on the use of public and institutional libraries than was possible seventy years ago when each engineer was forced to maintain his own technical library. The engineering society of today is therefore faced with an an ever-changing problem of distributing the technical literature it produces in the most economical and effective manner. In its attack on these problems ASME, in 1948, instituted changes in its publication procedure which are designed to provide an improved service for members.

Numerous solutions of the problem of economical distribution of papers of this type, none of which is completely satisfactory, present themselves. The traditional solution of the engineering society, distribution of every paper to every member, has become expensive and wasteful. This solution, which is satisfactory when societies are small and have programs devoted to a limited number of subjects, becomes the victim of its obvious advantages. It affords every member the privilege of making his own selection of what is valuable and useful to him, but, as society programs grow in diversity, it swamps him with much material of no immediate concern to him because of the all-inclusive nature of the subject matter presented and the limitations of his own specialized interest. Publication costs are high because of the large number of copies that must be printed to satisfy the needs of a membership which, in the case of ASME, is rapidly approaching 30,000. Hence publication budgets must grow outrageously to keep up with the ever-increasing number of members to be served; or the number of papers published must be decreased in order to keep publication expense within the limits of a reasonable budget. These considerations were strongly influential in leading ASME, in 1948, to abandon free distribution of its Transactions to all members in favor of a subscription scheme.

An alternative distribution scheme is to be found in specialized or limited-interest publications. This scheme has strong appeal because it combines all the papers related to a specific field of subject matter in one of several periodical publications. The ASME tried out such a scheme in 1927, using the professional divisions as the basis of the classes of subject matter to be grouped together. There resulted groups of papers devoted to applied mechanics, aeronautics, fuels and steam power, and the like. Registration in the professional divisions provided the mailing lists for these "divisional" sections of Transactions. The plan was abandoned in favor of an all-inclusive monthly periodical, but reappeared a few years later, in modified form, with the concentration of all applied-mechanics papers in four of the twelve issues, thus constituting the quarterly known as the *Journal of Applied Mechanics*.

The success of the *Journal*, and the success of schemes adopted by other societies which set up several periodicals, each devoted to some restricted area of subject matter, led to the hope that proper combinations of Transactions papers would provide additional quarterlies. Study of the scheme by several committees has so far failed to develop a practicable solution of some of the problems that it raises.

Two other variations of the limited-interest publication, neither of which lends itself to periodical publication and hence lead to high mailing rates, deserve mention. One involves special publications such as proceedings of a conference, monographs on specific subjects, and groups of papers on related subjects. With such special publications ASME has supplemented its Transactions for years. The second variation abandons both the magazine and the "proceedings" form of publication and substitutes for them the separate publication of

every individual paper, except, possibly, in the case of two or more papers originally written to supplement one another. Such a scheme would represent the ultimate in the fragmentation of ASME Transactions, which began as a collection of selected papers and other materials, issued annually in a single bound volume, which developed into a monthly periodical, and which would end, were the scheme to be adopted, in a series of separate papers, destined to be filed in any number of ways, and in varying degrees of completeness, by individual users. Large public and most engineering libraries would probably maintain complete bound sets of a year's collection of such papers, but it is not likely that ASME Transactions, under such a scheme, would maintain a recognizable identity.

The present ASME preprints constitute a step toward this "separate" or pamphlet publication scheme. But in the form adopted by the Society they supplement the periodical publications without replacing them. The Transactions, still issued monthly and available in an annual bound volume, has the advantage of permanence for reference purposes, while the preprints, which include many papers never before used in ASME periodical publications, can be purchased for personal use as soon as they are available.

The ASME publication plan, put into effect in 1948, was successful in reducing Transactions expense because subscription was substituted for free distribution. It frankly recognized the archive character of papers to be included in Transactions. By increasing the number of preprints of technical papers available for purchase by members—not only Transactions papers, but also papers heretofore seldom available in published form—and by means of digests of practically all ASME papers in MECHANICAL ENGINEERING, useful supplementary services were offered members. Although a member must pay for subscriptions to Transactions and the *Journal of Applied Mechanics*, and for whatever preprints of papers he wishes for personal use, he himself can decide, on the basis of his needs, the extent of his purchases. If he does not subscribe to these magazines, and if he does not purchase preprints of papers, he still has the MECHANICAL ENGINEERING digests to keep him up to date on the availability of ASME papers, and he can find the papers themselves in a considerable number of libraries.

General-Interest Publications

CHANGES in ASME publication procedure instituted in 1948 not only threw into sharp relief the significance and character of specialized or limited-interest technical papers of high quality and permanent reference value; they also made it clear that a substitute for the free distribution of Transactions must be offered and directed attention to the general-interest aspects of ASME publications. Several substitute services were instituted. Decision was taken to make a greater number of preprints of ASME papers available in one form or another. Much of the success of this effort depends on the early receipt of properly reviewed manuscripts, a task involving hundreds of authors and committeemen serving on a volunteer basis. But once such a manuscript is available, it is the promise of the Publications Committee that it shall appear in some form in MECHANICAL ENGINEERING. This means that it will be printed in full or reasonably complete form, in condensed form as an article usually assigned to the "Briefing the Record" section, or in digest form in the "ASME Technical Digest" section. Regardless of what form this publication may take, selection, if publication is complete, and treatment, if a condensation or digest is used, conform to a "general-interest" requirement. For MECHANICAL ENGINEERING, which has a large circulation and attempts to cover an extensive and diversified field, can be most effective when it conforms to a general-interest pattern.

It is the aim of a general-interest engineering magazine to make better engineers in every sense of the word. In order to do this, it should appeal to all its readers. This does not mean that every article or item will appeal to every reader; the diversity of reader interest is too great for this. But even a single article may have a value out of all proportion to what may be anticipated. One remembers that it was the reading of an article on the use of compressed air in driving the Mont Cenis Tunnel that started Westinghouse on the air brake and a career as one of the great engineer-industrialists of his age.

Cross-fertilization of ideas is one of the most important functions to be performed by a general-interest magazine. When the specialist writes a specialized or limited-interest paper, he is likely to have none but other specialists as readers, but when he writes for a general audience and concentrates on the significance of his message, he may awaken a responsive chord in a reader whose work lies in an entirely different field and set an active mind at work on applications of great value. By means of a general-interest magazine, one field of engineering becomes fertilized by ideas developed in another, many times so remotely removed that purposeful investigation of it is overlooked by the author of the original paper.

The general-interest magazine affords a means by which an engineer may easily keep abreast of what engineers in other fields are doing. Certainly anyone who reads the ASME Technical Digest section regularly will get a fairly representative idea of the technical papers presented and discussed at ASME meetings, and much more quickly than if he set himself the task of reading all the papers themselves. It is not claimed that these digests contain the entire substance of the papers. They are designed to be informative on their own account, and they provide the reader with sufficient data so that he can find the original, if it suits his interest to do so.

Having assumed the task of providing readers with the substance of every ASME technical paper for which a manuscript exists, MECHANICAL ENGINEERING takes on, even more definitely than it ever has in the past, the characteristics of a general-interest magazine. The field is broad and useful material is abundant. Changed publication procedures are forcing the issue which calls for intensive effort if the plan put into effect in 1948 is to serve the average member better than ever before.

POWER GENERATION

By A. G. CHRISTIE

EMERITUS PROFESSOR OF MECHANICAL ENGINEERING, THE JOHNS HOPKINS UNIVERSITY, BALTIMORE, MD. PAST-PRESIDENT ASME

DURING the last fifty years electrical energy has become a necessity of modern life. It furnishes light and power to homes and industry. In many sections even the humblest home has electric lights and radio. Farmers use electricity to an increasing extent. Electrical service thus forms a major element in the high standard of living enjoyed by all on this continent.

Granted that electrical energy is a necessity, assurance of its adequate supply becomes an important social problem to all citizens. The late war placed heavy demands on the supplies of electricity in order to serve our industries. Unessential plant additions and domestic customer extensions were deferred until after the war. The pent-up demand when war stopped was so great that deliveries of equipment for new plants were delayed and, at the same time, a remarkable growth occurred in domestic and industrial consumption. As a result, shortages occurred and customers had to submit to restrictions on their uses of electricity. Thus the adequate supply of electrical energy has assumed a paramount importance, and discussion of sources of energy and future power generation is therefore timely.

LOAD GROWTH

The rate of load growth has become a critical factor in power generation and supply. This growth has been continuous over an extended period regardless of wars and depressions. It has been the experience of many electrical systems that the growth of load during the first few years after a war or depression has been so rapid as to bring peak loads back to the normal projected curve that would have represented load growth had no interference occurred. The experience of the last few years with extremely rapid load additions confirms this principle. Had it been possible to satisfy these growing demands at an earlier date, there would have been a somewhat lessened rate of increase in present peak-load demands. However, inability to build new plants and to get equipment for such plants, together with the fact that there is little or no reserve available in large systems today, have combined through necessary load restrictions, to continue the critical demands for a few years more.

Satisfaction of present demands by no means solves the problem. Power-system growths are such that normal annual increases will call for relatively large unit capacity additions each year. This is evident from the experiences of the Hydro-Electric system of Ontario where annual growths of the order of 100,000 kw per year may be anticipated for the next few years. In ten years this would mean that at least 1,000,000 kw of plant capacity must be provided for normal growth. Such growth will require not only a large engineering effort but will represent an investment of more than $200,000,000.

The Hydro-Electric system is not an isolated case. Mr. A. C. Monteith speaking in Chicago, last year, pointed out that in 1947 there were installed in the public utilities of the United States, 52,000,000 kw of capacity. By 1957 there would be 90,000,000 kw needed to care for normal growth, and by 1977 this would have increased to 250,000,000 kw. In its 1948 annual report, the Allis-Chalmers Manufacturing Company states that 26,000,000 kw must be added between 1948 and 1953. Such figures indicate at the moment that about 5,000,000 kw of new capacity must be installed each year for several years to care for load growth alone. But more than that must be added to increase the margin of reserve in power-generating stations which is now too low for satisfactory operation. Also, older machines are wearing out and must be replaced while other units have been rendered uneconomical by the recent increases in fuel and labor costs. The present limit on system increases in the United States is to some extent fixed by the capacity of the manufacturers' shops to build prime movers. Large steam turbines cannot be obtained in less than three years from the date orders are placed.

These considerations indicate that the power industry will be very active for some time to come. Also, it should be clear that the satisfaction of these increasing electrical demands is not an easy problem, and that occasions may arise again when service to customers must be temporarily curtailed.

SOURCES OF ELECTRICAL ENERGY

Electrical energy can be supplied by hydro, steam, or internal-combustion generating stations. At a future date, gas turbines, wind power, energy from the sun, mercury vapor, and atomic energy may supply a portion of the demands, but much development remains to be done to make these systems commercial.

A primary object in power generation is to furnish electricity at minimum cost for the given locality. This naturally depends on the local availability of water power or fuels and of other auxiliary needs such as cooling water for condensers. This availability varies from place to place, and hence each power plant becomes a separate engineering problem. Increases in fuel and labor costs have required a restudy of marginal hydroelectric sites. Such hydrodevelopments, however, must bear a heavy burden of capital charges due to high construction costs.

When electrical distribution first started, a number of frequencies were used, 25, $33\frac{1}{3}$, 40, 50, 60, and $62\frac{1}{2}$ cycles. In the United States these have been or are being changed to 60 cycles which is becoming the national standard frequency. The Niagara portion of the Hydro-Electric system was started with a 25-cycle frequency. Other portions are 60 cycle. At present 60-cycle equipment is available for every desired service. Twenty-five cycle lights are particularly trying. There seems to be every reason for changing the older sections of the Hydro system to the standard 60-cycle service.

Labor and material costs per kilowatt of capacity in new plants have practically doubled since 1939, and show little tendency to decrease. All new system additions will carry these high costs. The capital charges on these plants will be reflected in future power costs to the customer unless offset by increases in the average use of installed capacity or, in other words, by increased load factors of the consumer.

Plants installed to carry peak load only produce high-cost energy, since peak loads are of short duration and few kilowatt-hours are produced per year. On the other hand, incremental capacity to carry peak loads generally can be added at low cost to a hydro storage plant and can carry peak loads by drawdown of stored water. This is a factor in favor of increased water-storage capacities.

It is difficult to justify the scrapping of old steam plants

Paper presented at a meeting of the Ontario Section, Toronto, Ontario, Can., April 14, 1949, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

if they are still in operating condition. Such plants can be used more economically for a few hundred hours per year to carry peak loads than high-cost new equipment, in spite of high fuel consumption per kilowatthour.

Hydro-Electric Generation. Ontario has no coal and little petroleum. Therefore advantage must be taken of water power wherever it can be developed economically. Unfortunately, many of the larger power sites are distant from load centers. The international section of the proposed St. Lawrence River development would provide Ontario with about 1,000,000 kw. But other sources of supply are needed before the St. Lawrence plant could be completed. A second Queenston plant using Niagara water now supplied to the older plants at the Falls would increase kilowatt output, owing to the larger head available at Queenston from by-passing the lower rapids. Consideration should also be given to possible treaty modifications which would permit additional withdrawals of water at Niagara for power generation. Surely the essential needs of the people of Ontario and of New York State transcend the pleasure of the decreasing number of people who view Niagara Falls as a spectacle.

At the moment, Ontario has to turn to the Ottawa and other northern rivers and even Sault Ste. Marie for added hydro capacities. These potential developments are at considerable distances from the load centers. This suggests the need of a thorough study of all large and small power sites in the more central portion of the province and the possibilities of additional water-storage facilities at headwaters of the several streams. Such storage combined with flood prevention may justify the development of many small powers near at hand but at present are not considered economical. Operating costs could be reduced by installing automatic generators as in certain California plants. Such small units feeding into the present central distribution network would result in less transmission losses than with lines from distant points. Storage would also assure adequate water for domestic and commercial use in growing industrial communities of Ontario. Such industrial water supply is becoming critical in certain sections of the United States.

Objection may be raised that the development of many small sites is expensive. The construction of hydro plants on distant rivers together with long transmission lines is also expensive.

Quebec, Ontario, Manitoba, and British Columbia can still supply their major electrical requirements from hydroelectric plants. Hence the need for stressing all phases of hydroelectric power developments.

Steam-Generated Power. About three quarters of the installed capacity of public utilities in the United States are in steam plants, and one quarter in hydro stations. This is due to the wide distribution of the ample fuel supplies. The hydroelectric plants operate as nearly as possible on base load and hence develop about one third of the total kilowatthours. Fuel is thus saved at interconnected steam plants and total costs reduced.

Fuels burned include coal, fuel oil, natural gas, and some few waste products. A recent report states that the national average equivalent fuel consumption of steam central stations for 1948 was about 1.2 lb of coal per kwhr send-out. This figure will decrease continually as more new stations commence operation and older plants are retired. Many new plants will operate on 0.85 lb per kwhr with a number expected to produce a kilowatthour on 10,000 Btu, or about 0.75 lb of coal. Still lower fuel rates may be expected if coal costs and freight rates continue to rise.

A joint ASME-AIEE committee chose certain "preferred standards" for large steam-turbine capacities, and their operating steam conditions, with the expectation that such standard machines could be obtained at a lower first cost and in shorter time than nonstandard units. Standards have been well received, and an increasing number of these machines are being ordered for new installations. The standards which have been given wide publicity, cover unit capacities of 11,500, 15,000, 20,000, 30,000, 40,000, and 60,000 kw operating at 3600 rpm. Steam pressures, temperatures, and vacuum are also standardized. It is probable that a new standard for still higher capacity will be chosen shortly. Turbogenerator sets are now available up to 80,000 kw at 3600 rpm, and to sizes up to 200,000 kw at 1800 rpm. The higher-speed units are favored owing to lighter weight, smaller size, and better operating characteristics with high steam temperatures.

Another move to decrease station cost is to place the greater portion of the steam-generating plant and its auxiliaries out-of-doors. This is practical in southern sections of the country, but is less favored in the colder sections of the north.

When the preferred standards were set up, the highest pressure and temperature conditions selected for the throttle were 1250 psig, 950 F. Much higher conditions are now being employed, the highest recent installations being 2000 psia, 1050 F. A number of stations are being planned for 1450 psig, 1000 F, and 1000 F reheat. While the reheating plant is somewhat more complicated than the nonreheat, its fuel saving is estimated as to 4 to 6 per cent over nonreheat, and this justifies its added cost. Some new stations expect to operate on 9500 Btu or 0.7 lb of coal per kwhr, a send-out which represents an over-all thermal efficiency of 36 per cent. Much study is devoted to the development of metals that can stand extremely high temperatures. Steam temperatures of 1400 F are in use in the petroleum industry. Some gas turbines are operating at 1500 F. Hence one may expect that still higher pressures and temperatures will be employed in steam stations with still further gains in thermal economy, possibly to 0.5 lb of coal per kwhr.

Typical Steam Plant. Let us consider the principal features of a modern steam power plant. Location must be considered with regard to access for machinery and fuel shipments, availability of ample cooling water, and nature of subsurface conditions for foundations. Shipment of both equipment and fuel may be either rail- or water-borne or both. Cooling towers or ponds are used only where there is little available water as at mines or in desert country. In general, river, lake, or sea water is used for condensing purposes. The magnitude of this water demand in a modern station may be stated as about 240 tons of cooling water or 7700 cu ft per 1000 kwhr. A 60,000-kw unit with four bleeder heaters, operating at 1250 psig, 950 F, and 1 in. abs vacuum, exhausts 356,800 lb of steam per hr to the condenser and requires about 28,544,000 lb of cooling water per hr, or 47,600 imperial gal per min. Foundation conditions along rivers and harbors are often bad, and these lead to expensive substructures. Sufficient land must be provided for ultimate plant extension and for fuel storage which, in the case of coal, must be extensive to provide for frequent stoppages of supply from strikes, or, in the case of northern plants, to carry the plants over the winter season.

Coal handling is generally done by grab buckets from barges or by car dumpers on railroads. Bradford breakers deliver this coal to belt conveyers which either discharge to storage or elevate to bunkers in front of the boilers. Bulldozers and carryalls are used to either store out or reclaim coal in the storage yard.

Large storage tanks in the yard care for fuel oil. In cold climates these may require heating to insure free flow of oil. Natural gas is not stored in large quantities.

Coal-firing equipment may consist of spreader stokers for steam generators up to 250,000 lb per hr. These are more adapta-

ble to varying types of coal than other stokers, provide good efficiency, and have shown low maintenance costs. These stokers are the preferred means for burning western lignites. Overfire air may be needed for their most economical operation.

Whether stoker equipment or pulverized coal is to be used depends on the grindability of the coal. Low grindability, poor ignition qualities, and high moisture in available coals may favor stokers.

Large plants generally employ pulverized-coal firing and large furnaces. Heat-release rates of 18,000 to 25,000 Btu per cu ft per hr are now general in dry-bottom practice. These low rates insure satisfactory operation with different kinds of coal and also avoid heavy slag formations on the furnace walls, which consist of solid water-cooled tubes. Furnaces are often of great size insuring that the flame at maximum load is thoroughly burned out and the gases cooled below ash-softening temperature before crossing any convection cooling surfaces. Dry ash from the hopper bottoms is removed by water sluicing to a pit, from which it is picked up by a grab bucket. Wet-bottom furnaces have stud-tube walls coated with refractory, and the ash remains fluid until it runs out into a water-filled pit from which it is removed by a grab bucket, or is sluiced out.

The cyclone furnace recently developed in Chicago is very promising. The coal needs only to be crushed and is burned in a water-cooled cyclone combustor outside of the furnace proper. It appears to be suited best for burning coals with low-fusing ash. Practically all the ash in the coal is retained in the molten slag, and comparatively little escapes in the flue gases.

Pressurized furnaces are being studied. These simplify equipment, will probably reduce boiler size, and may be available at lower cost. Only a forced-draft fan is used on which maintenance is low, due to handling only clean air.

Steam generators have changed much during recent years. These are now built in capacities up to 1,000,000 lb per hr. Water-cooled furnace walls absorb by radiation most of the heat required to evaporate the boiler water. Convection surfaces are of small extent and generally serve merely as slag screens or as downcomer tubes for water.

Superheater surfaces become large as the entering gas temperature must be below the ash-fusing temperature. Superheat control is necessary and is secured by several means such as desuperheaters, by-pass dampers, or burner control. The extent of economizer surface is fixed by the feedwater temperature from the bleeder heaters of the turbine and by the air preheat desired. These are generally nonsteaming, with water leaving 50 deg F below boiling temperature at full load. Air preheaters of the tubular or Ljungström type reduce the flue gases to about 300 to 350 F at full load. Tempering devices or by-pass dampers are provided so that at light loads these gases do not fall below their dew point. Steam-generator efficiencies range from 85 to 88 per cent with coal, about 3 per cent less with fuel oil, and 6 per cent less with natural gas.

Boiler feedwater in high-pressure boilers must be conditioned carefully to be free from oxygen and scale-forming salts, and concentrations must not exceed specified values; for instance, with 1500 psi, concentration must be less than 1000 ppm. In condensing plants the feedwater is condensate with distilled-water make-up. Boiler surfaces are acid-cleaned with dilute hydrochloric or lactic acid, if any scale forms on them. Steam generators are automatically controlled to maintain best efficiency under all loads. Large control boards carry all necessary instruments for intelligent operation.

Smoke Reduction. The American public is becoming smoke and dust-conscious. Hence all new stations are provided with devices to eliminate the dust from the flue gases. These may consist of electrostatic or mechanical separators or combinations of these. No economic use has been found for the fine dusts recovered in these separators. When pulverized coal is burned, about 80 per cent of the ash in the coal is carried over by the flue gases and must be removed by the dust catcher. Sulphur in the flue gases is also receiving consideration.

Both forced and induced-draft fans are used with means to regulate their pressures and volumes such as inlet-vane control or some form of variable-speed control, or both. Considerations of the dispersion of the smoke plume govern the height of chimneys and the velocity of discharge of the gases from the chimney. This is leading to somewhat higher but smaller chimneys than formerly. Exit velocities from chimneys of 110 fps have been used to insure satisfactory dispersion.

Turbogenerators. Turbine generators may be of the single-shaft type, or in large units may have a 3600-rpm high-pressure section and 1800-rpm low-pressure unit. This makes a large set, and consideration is being given to two-shaft 3600-rpm units with multiple exhausts. Steam turbines are provided with three to six points of steam extraction for feedwater heating. These heaters, generally of the closed types, are often vertical with hairpin tubes. Deaeration may occur in the hot well or a separate deaerator heater may be furnished. A 10-min storage of condensate should be provided on the feed system to equalize boiler demands.

Generators of 15,000 kw capacity and above are hydrogen-cooled with $^1/_2$ lb hydrogen pressure. If this pressure is raised to 15 lb, the capacity of the generator increases about 15 per cent. Water-cooling coils for the hydrogen are incorporated in the generator frame.

It is now general practice to install only one steam generator per turbine even with large units. The availability of these steam generators is practically the same as that of the turbine generators.

Piping. Piping is a problem with high pressures and temperatures. Chrome-molybdenum steels with suitable stabilizers are used for temperatures over 825 F. The heavy pipe walls required make small pipes with ample bends necessary to provide for expansion and resultant stresses although this involves large pressure drops. Some installations with one boiler-one turbine have eliminated valves between the superheater and the turbine stop valve to lessen station costs.

The surface condenser is rigidly attached to the turbine exhaust and rests on heavy springs to care for vertical expansion. Tubes are rolled at both ends with provision in the casing or by bowed tubes for differential longitudinal expansion. Condenser design has greatly improved over recent years. These are now built in sizes up to 100,000 sq ft.

Steam Jets. Steam jets remove noncondensable vapors from the condenser. Two-stage condensate pumps with pressure-sealed glands deliver the water through low-pressure heaters to the deaerator or to the centrifugal boiler feed pump. In high-pressure services the barrel type of boiler feed pump is preferred to those with horizontally split casings. Circulating pumps for condenser cooling water were formerly of the horizontal type, taking water from a tunnel under the turbine room. At many new plants, submerged vertical pumps are placed just behind the intake screens, and a cast-iron delivery pipe carries the cooling water to the condensers while a similar pipe returns the heated water to its discharge channel. These pipes are connected to the condenser by rubber expansion joints. Cooling water is chlorinated to keep down algae and mussel growths in the intakes and in condenser tubes. Traveling screens remove rubbish, grass, leaves, and the like, at the intake.

Electrical transformers and switching equipment, following the practice of the Hydro-Electric system, are practically all out-of-doors. Only service boards are indoors.

Industrial Steam Plants. Steam stations for industrial plants are built along the same lines and employ similar but smaller

equipment. Turbine generators are generally provided with extraction openings from which steam may be withdrawn for industrial uses. When the condensate from such uses is not returned to the plant, an elaborate water-treating system must be installed to condition the raw-water make-up.

The space-heating season is long in Canadian cities and towns, and average temperatures are low. Consideration should be given in such places to central heating plants. It is possible to design such plants with supplementary steam generators which may serve as reducing valves and supply electricity when available to the power system, or may be held as emergency stand-by units. A system of thermal storage might be incorporated in such plants to improve operating economy.

Steam stations may also serve as stand-by plants to distant hydroelectric generating stations. This is the case in California where large stations in Los Angeles float on the line to care for outages on the Boulder Dam transmission line.

MERCURY STEAM PLANTS

Several mercury steam plants have operated successfully for several years in the United States. Their economy has been high. A new plant of about 40,000 kw total capacity is being built in New England. It is the general opinion that such a plant is economically justifiable only where fuel costs are extremely high.

INTERNAL-COMBUSTION ENGINES

Diesel engines are used in many industrial plants, in small municipally owned plants, and in regions of plentiful petroleum fuels. Modern types are available which use either oil or natural gas, or any combination of these. Such engines will find a place in Alberta and Saskatchewan where oil fuels and natural gas are becoming abundant.

Diesel engines are available in sizes up to 5000 kw, although few of that size have been built. They have a shorter life and require more maintenance than steam-turbine plants. Therefore their use will be confined to the smaller plants. The high first cost of Diesel plants results in high fixed charges which partly offset fuel economies which in service are generally not as good as test results.

A new type of pancake Diesel engine has been developed recently, which is said to be lower in first cost than standard units and gives equally good economy.

GAS TURBINES

Gas turbines for electric-power development have been overexploited with the public. These units are of great promise but much development work must still be done before these are as commercial as the steam turbine.

Many different cycles of operation have been proposed and quite a number of these have reached the experimental stage. The realization of high efficiencies on such units depends largely on the employment of high gas temperatures entering the turbine, and the development of suitable metals or refractories to withstand these high temperatures while revolving at high speeds. Encouraging progress is being made in these researches.

Development of gas turbines in the United States was delayed by the war so that the largest plant now under construction is a 5000-kw unit being built by the General Electric Company. In Europe units of 14,000 kw and 27,500 kw have been built by the Swiss and are in operation, though performance records are not available.

The capacity and efficiency of a gas turbine improves with a decrease in inlet-air temperature. Hence such units are favored for winter operation in Canada.

Gas turbines at present in operation consume either fuel oil, natural, or artificial gas. During the past three years the coal-fired gas turbine has been under development for locomotive use. Pilot-plant results have been encouraging. The first turbine being built by Allis-Chalmers has been delayed 9 months by strikes, but it is expected that the locomotive will be moving on the rails by fall.

First-cost and efficiency considerations indicate that the gas turbine is not competitive with the Diesel for generation of electricity in sizes below 3000 kw. However, there appears to be a real place for gas turbines in sizes from 3000 to 25,000 kw. Therefore it appears that this new unit will not be competitive with either Diesel engines or large steam turbines but will provide a highly efficient unit in the intermediate capacities. Several American utilities are considering gas turbines for peak operation in load centers at the distant ends of their transmission lines.

ATOMIC ENERGY

The public has been led to expect much of atomic energy. Those who know most about the development of such energy are not allowed to express their views for security reasons. However, sufficient publicity has been given to the so-called "atomic pile" and to its construction to give engineers some opportunity to appraise its possibilities.

The nuclear reactions take place inside a huge block of concrete. Enormous amounts of energy in the form of heat are evolved by the reaction. This heat has been carried away by circulating cooling water at a comparatively low temperature through metal piping. One proposal is to generate steam with this heat for use in turbine generators. Another proposal is to employ gas turbines using the pile to heat the gases entering the turbine. No one has stated what will be the effect of neutrons on metals at high temperatures, nor of effective means to dispose of radioactive water or exhaust gases, or of the waste products of the pile stuff. Hence one can allow a further development period of possibly ten years to perfect a method of power development by atomic energy.

Even when this is accomplished, it is doubtful if the energy costs will be competitive with those from water power or coal. A report submitted to the United Nations contained estimated costs of power from atomic energy. These figures were considerably higher than present average power-production costs from steam plants.

While atomic-energy plants may be available in the future, present indications are that much development work is necessary before these are available. During that period, as previously noted, some 40,000,000 kw must be added in steam, hydro, and internal-combustion plants to supply demands already in sight in the United States alone.

CONCLUSION

In the foregoing, some considerations have been discussed of power generation, as related to conditions on this continent and particularly in Canada. Hydroelectric power should be developed to its economic limits. However, steam power has a place in hydroelectric systems and probably will be used to an increasing extent. Diesel engines or gas turbines at outlying load centers may prove the economical solution for peak loads at such places. Their stand-by costs are low. They can be started quickly. Their fuel consumption is small. They not only can carry the local loads on peaks but can relieve the transmission lines of losses and make this power available elsewhere. When more western oils are available in Ontario these should receive some study.

Power generation is a big subject. There is no single answer to all situations. It calls for the best thought of our most able engineers. Its problems will be with us for many years.

The DESIGN *of* OFFICE MACHINES

Illustrating Factors Involved in Such Machines as Calculators

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INTRODUCTION

THE design of office machines is greatly influenced by the following:

1 The volume of demand for the machines.
2 What is expected of the product.
3 The tools, material, and processes used in producing the machines.

It is the purpose of this paper to discuss briefly the effect of each of these factors upon the design of office machines, with particular reference to portable machines such as calculators; then to outline some of the methods and practices employed in the design of such machines, and to present an example of such design.

DEMAND FOR OFFICE MACHINES

It is well known that we in the United States of America go further than other peoples in mechanizing our tasks. In our offices this tendency has been accelerated by a marked increase in the reports and statistical information which are now required of every business. This increase is due to the following:

1 The discovery that more adequate information, more promptly supplied, makes for greater efficiency in the conduct of business.

2 The demands of our more complicated economic life, as reflected in the vastly greater amount of detailed information required by all levels of government.

As a result, the volume of recording, totaling, typing, and computing is such that every business has to carry on a sufficient volume of office work to be affected considerably by the efficiency with which that work is performed, and almost every office requires a greater or less degree of mechanization, involving at least a typewriter, cash register, adding machine, or calculating machine. Furthermore, the export demand for supplying such machines to the rest of the world adds a considerable percentage to the domestic demand here in the United States.

The result is that the demand for manufacture of each of these kinds of machines within the United States is great enough to encourage employing engineering-design techniques based on the use of tools and processes of manufacture which minimize the amount of labor, particularly of highly skilled labor, required in the production of each machine. This course is further dictated by the relative scarcity and high cost of skilled labor in this country.

In Europe, the demand, especially for the more expensive and highly automatic types of equipment, has been sufficiently more limited, so that, combined with the greater availability and lower compensation of highly skilled labor, the European design has tended to involve much more individual machining of unit parts. This includes the milling and facing of castings and of bars or slabs of brass and other stock, and the machining of specially shaped cams, mutilated gears, and other irregularly shaped parts. Such work is almost completely avoided in the best American designs.

PRODUCT SPECIFICATIONS

The specific requirements expected of different types of office machines differ so greatly that it is impossible to generalize in regard to such requirements. However, in general, it may be said that most office machines, including particularly the more automatic types of calculating machines, bookkeeping machines, and the more elaborate types of cash registers, require that a very large amount of mechanism for accomplishing automatically a great variety of relatively complicated sequences of operations must be embodied in comparatively small space at a minimum of cost consistent with the high accomplishment expected. Particularly in portable machines, such as the desk type of calculators, there seems to be an insistent demand for minimizing the size and weight of a great mass of highly automatic mechanism. This limitation on space to be occupied has a marked effect on resulting design.

The large number of unit parts involved dictates that the unit cost of each part must be kept very low, for instance, about 1 cent for manufacturing each part and another cent for assembling it and adjusting it to perform its function in the machine. On the other hand, the requirement for minimum size and weight necessitates manufacturing to close tolerances so as to minimize the following:

1 Size of parts.
2 Amount of movement required for accomplishing a given function.
3 Clearances required between parts.
4 Possibility of interference or undesired contact between moving parts.
5 Failure of co-operating parts to engage properly and co-operate with each other.

TOOLS, MATERIALS, AND PRODUCTION PROCESSES

In order to minimize the unit cost of parts produced and yet work to close tolerances with the maximum of dependability and minimum of inspection required, it has been found, at least with calculating machines and to a considerable extent with other similar types of office equipment, that it is most advantageous to plan on producing most of the operating mechanisms of the machines over two basic machine tools, namely, the punch press (for all parts that can be made from flat stock), and the automatic screw machine (for all parts to be made from round stock).

Punch Presses. Most of the primary working parts of a modern calculating machine or similar piece of office equipment, and many of the other parts, such as covers, frames, and the like, are made from cold-rolled strip steel, processed through punch-press dies. Dies may be built to perform any desired sequence of such operations as blanking, shaving, piercing, forming, swaging, extruding, drawing, trimming, coining, or the like, and the parts should be designed for the most economical and dependably accurate production that combinations of these operations will provide.

Contributed by the Machine Design Division and presented at the Semi-Annual Meeting, San Francisco, Calif., June 27–30, 1949, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

Cold-rolled strip (ordinarily called "bright punching steel") of something like an AISI 1010 analysis is most frequently employed for die-made parts of office machines. Most of the working parts of a modern calculator, for instance, are made of stock of from 0.025 to 0.062 in. thick. The temper of such strip will vary according to the amount of cold-working to which it has been subjected since last annealing in the rolling process. The designer specifies the temper most suitable for the part. Dies produce the most satisfactory edges on the hardest temper, but if forming is involved somewhat softer temper must be employed, and for drawing still softer temper is required.

A tolerance of ±0.002 in. ordinarily provides reasonable allowance for variations in die manufacture and in wear of the die during its life. Approximately this amount of tolerance is most frequently provided between important working surfaces of the die-made part. Coarser tolerances than this will reduce the cost of making and maintaining the dies, and tolerances up to ±0.010 in. are provided frequently on the less important portions of a die-made part. On small hole sizes and where requirements are otherwise especially exacting, tolerances of ±0.0005 in. or closer can be held.

Automatic Screw Machines. An automatic screw machine is in effect an automatic lathe adapted to perform automatically any desired combination of cutting, forming, centering, drilling, reaming, threading, tapping, recessing, knurling, cutting off, slotting, and other operations. In general, each operator can tend from two to four automatic screw machines.

Screw-machine stock such as AISI 1112 or X-1112 is a high-sulphur and high-phosphorus, easy-cutting stock, and such a stock is usually employed for most screw-machine parts, both because it permits high cutting speed with low tool wear, and also because it produces a better cut finish than with most other stocks. However, these stocks are somewhat unpredictable in their carburizing and heat-treating characteristics, so that, where deep cases and accurately controlled heat-treating characteristics are essential, some poorer-cutting stock must be employed, such as AISI 1010, for instance.

Special results may be obtained by feeding specially shaped stocks to the automatic screw machine. Hexagonal stock can of course be employed to produce hex-head screws or bolts, and hexagonal nuts. Pinion rod, either drawn to contour or (if greater accuracy is desired) hobbed in full rod length, may be cut up into finished gears in the screw machine, and such a method is particularly economical and desirable in the production of extremely small gears.

The automatic screw machine provides a means for reproducing economically a great variety of turned parts to close tolerances. In general, the tolerances allowed for screw-machine parts are comparable to those mentioned for die-made parts, but it is slightly easier to hold closer tolerances, especially on certain dimensions of small parts, than is generally true with the die-made parts. For instance, on small parts having center holes of the nature of $^1/_{16}$ to $^1/_8$ in. and outside diameters of $^1/_8$ to $^3/_8$ in., it is possible to hold these diameters as close as 0.0005-in. total tolerance. Where the unturned outside diameter is desired at this close tolerance, so-called "needle bar," which is specially ground screw-machine stock, is economically obtainable on the market.

Heat-Treatment. Most of the working flat parts and some of the round parts of most office machines are subjected to heat-treatment. Because of the small size of the parts employed and the type of the loads to which they are ordinarily subjected, high-carbon steel is seldom used, but a steel with about 0.10 per cent carbon is subjected to a treatment which will leave a soft tough core but provide a thin extremely hard case, usually 0.001 to 0.004 in. thick. For most of the parts of a calculating machine, or similar piece of office equipment, this is accomplished by immersion in sodium cyanide at about 1500 F and quenching in oil.

However, if a part sustains any heavy blow in its operation which would tend to dent or upset the part, a much heavier case ordinarily is required, usually at least $^1/_{32}$ to $^1/_{16}$ in. in depth. This may be provided by carburizing. For expeditious and reasonably clean handling of the small parts concerned, a liquid carburizing bath usually is employed if a part is to be carburized all over, while, for selective carburizing, an electrically heated gaseous carburizing furnace may be used. In this latter case, the part is copperplated everywhere except the area to be carburized, the copperplate serving to block off the carburizing action wherever it is present.

TYPICAL DESIGNING PROCEDURE

Layouts and Experimental Models. The general conception of how a new machine, or a new model, is to function is generally first set forth by the inventor in a written disclosure accompanied by sketches. This disclosure may be prepared in response to specific requests from the company management, or sales organization, and may be the result of extensive research into the commercial demand and requirements for the proposed product, or it may be solely the result of thinking on the part of the inventor himself.

It is good practice to have a machine so designed that most of the parts of the machine can be assembled into a dozen or so separate units, so that the final assembly of the entire machine consists in little more than bringing together the separate units, establishing and adjusting the proper connections, and checking the over-all functioning of the machine. When an entirely new machine, or extensive parts of the machine, are to be designed, the development engineer ordinarily will endeavor to plan tentatively the extent of such units in advance, and to assign the design of each such unit to a different designer.

With the disclosure in hand, the designer starts to work out in greater detail and accuracy some general sketch layouts of the mechanisms involved, and then to prepare an accurate engineering layout. Because of the small size of the parts, and the small movements and close tolerances involved, the main engineering layouts are usually made on a 5:1 scale. Where special details require more careful study, special layouts of the parts concerned frequently are made at scales of 10:1 or 20:1.

Early in the layout the cumulative effect of tolerance variations should be estimated. This may indicate that (1) it will be impossible to secure the desired results with adequate allowance for manufacturing tolerances, or (2) that normal manufacturing tolerances will have no effect on the result and can be neglected in the further layout work, or (3) most frequently, that the actual condition lies intermediate between the two foregoing conditions, in which case the layout study must include an analysis of the effect of maximum accumulation of tolerances.

When the layout of a given unit of the machine has proceeded to the point where a tentatively satisfactory design has been reached, it is then usual to detail an experimental model embodying one decimal order or one set of the new mechanisms. This model ordinarily is designed for hand and/or motor-power operation, and when built it is operated by the designer as well as by the experimental testers. Particularly if it is a radically new mechanism, there are sure to be some points discovered where the mechanism can be improved further. Depending upon the amount of redesign found necessary, there may or may not be one or more additional single-order models constructed embodying successive improvements on the design.

Next a multiorder unit embodying perhaps as many decimal

orders as the final machine may be constructed and power-operated to check the operation of the complete unit as nearly as possible in the manner it will be required to operate in the finished machine. Finally, a machine will be designed and constructed approximating the final commercial machine.

Many interesting problems in kinematics, dynamics, and other specialized types of investigation are encountered frequently in connection with the design, and special research groups often are maintained for the study of such problems. However, a great deal of reliance ordinarily is placed on the study of movements by means of large-scale layouts and templates, and the design of a part is determined more frequently by so shaping it as to provide a reasonable connection between its few primary working points, with the part designed so that it is well adapted to the production processes, than by accurate engineering analysis of the stresses or other such factors involved. Also, great reliance is placed on experimental test and study of the various mechanisms as embodied in the successive models.

A large proportion of American office machines are driven by electric motors having controls so integrated into the operating mechanisms of the machines that the design involves electrical as well as mechanical engineering problems. Some office machines make even further use of electrical components as, for instance, by employing magnets or solenoids to perform some of the basic machine functions.

Releasing Design for Production. When the development group is satisfied with a design, engineering drawings are prepared of each unit part, subassembly, and assembly, specifying the material, heat-treatment, finish, and usage of the part, and of course specifying tolerances on every dimension. For the first experimental model, such drawings usually are made in a very quick, rough form, and the more carefully delineated engineering drawings are prepared as the development approaches completion.

Most office-machine parts, particularly those of the die-made variety, are especially well adapted to being checked by means of a shadow projector or comparator. For this purpose accurate large-scale drawings (usually at 20:1) are prepared as soon as the first experimental design of a part is released. Such a drawing is of great help to the experimental-parts maker in getting his first handmade parts accurate to drawing, and it is equally useful in checking templates for die making, the dies themselves, the parts off the dies, and later production runs.

The work of the development-design men should be supplemented by a few individuals specializing in production design, it being the responsibility of these latter individuals to criticize every element of design from the viewpoint of production and service, and to call for the redesign, either by the development department or by themselves, of such parts and units as they believe require improvement. The method of bringing these production-design men into the situation varies a great deal, the following being typical:

1 Sometimes they work closely with the development group, reviewing the design as each stage thereof is completed, and checking carefully each experimental model, thus endeavoring to have their ideas built into the scheme as it develops.

2 In other instances the development engineer carries the project to substantial completion to his own satisfaction, and then brings in production-engineering experts or "analyzers" to go over the design carefully from the production, assembly, and service viewpoints. In this instance the development engineer, together with the production-engineering specialists, may carry the design actually through the first regular production lots.

3 A third method sometimes employed involves the development engineer's turning the new development bodily over to a production-design engineer when he is satisfied with it. The production-design engineer then takes full responsibility for the project and redesigns it to any extent that he considers necessary to make a really good production job out of it.

When all are satisfied with the design, and sales and general management approve the models embodying it, complete parts and usage lists are prepared. All engineering drawings and lists are then released to production planning for setting up in detail the production steps and tools required for the production of each part.

AN ILLUSTRATIVE DESIGN

A number of the phases of office-machine design, which are more or less common to large groups of office machines, have been mentioned. Reference also has been made to the fact that it is difficult, if not impossible, to generalize on the design problems imposed by the specifications of the particular machine being designed. Often these problems considerably overshadow, in their importance to the designer, the more general problems which have been discussed. Probably the best way to visualize the nature of these special design problems will be to review a particular design, for which purpose the author has selected a portion of a calculating machine.[1]

Objective of This Design. The basis of operation of the well-known types of calculating machines requires that during each calculating cycle each numeral wheel in the accumulator be rotated or advanced in either the positive or the negative direction during each cycle of operation by a number of digital steps corresponding to the digit set up in the corresponding key row (this amount of advance being termed "digitation"), plus one more digital step (termed "carry-over") in case the numeral wheel to the right has passed from 9 to 0 in the positive direction, or from 0 to 9 in the negative direction during the current cycle. It had been the general practice to impart the digitation and carry-over movements to the numeral wheels in separate phases of each calculating cycle, the digitation movements usually being varied in extent to accord with the digits selected, and the carry-over movements being imparted to the numeral wheels one at a time successively from right toward left. This had resulted in each numeral wheel standing still for a considerable part (usually the majority) of each cycle, and making one or two starts and stops each cycle.

The design that will be described was developed several years ago for the purpose of replacing this cyclically intermittent advance of the numeral wheels with a smooth and uninterrupted movement continuing throughout every calculating cycle. The object was to avoid the noise and wear of the repeated cyclic starting and stopping of the numeral wheels and their related mechanism, and, by not wasting any cyclic time, to secure the maximum of resulting movement at minimum speed of the mechanical parts.

The amount of advance required of a numeral wheel in any given number of cycles of machine calculation depends not only upon the amount set up in the keyboard opposite that numeral wheel, but also upon the amount of carry-over it receives, which in turn depends upon the amount set up in all columns to its right. Thus the amount of advance of a numeral wheel may depend upon the amount set up in all columns of the keyboard. In a machine of ordinary capacity there are millions of different such amounts that may be set up. By adopting a plan which requires that all numeral wheels move for precisely the same period of time, it follows that there must be as many rates of numeral-wheel movement as there are possible variations in the amount of advance required of

[1] More fully described in U. S. Patent 2,271,240.

the numeral wheels. However, it was aimed to provide this tremendous number of different rates of numeral-wheel movement by so merging a few basic component movements that each numeral wheel would always move at a constant and appropriate speed throughout every calculating cycle to bring it to its proper result position at the conclusion of any uninterrupted plurality of calculating cycles, without requiring any start, or stop, or variation in the speed of any numeral wheel from the initial start at the beginning of the plurality of calculating cycles to the final stop at the end thereof.

Nine-Speed Transmission 5/8 In. Wide. As a first step in this direction it was necessary to provide, under control of each row of keys, a transmission unit, having nine selective speeds in the ratio of the digits 1 to 9, inclusive, and also a locked condition corresponding to a zero digit. To obtain maximum ease of operation, it was decided that the gears should be shifted automatically by power into the proper gear ratios whenever the machine was operated, and not shifted by hand upon setting of the keys. To have all related ordinal mechanisms in direct alignment with the key rows and the numeral wheels on 5/8-in. spacing, each nine-speed transmission unit, and all the mechanism for power shifting it, was limited to a width of 5/8 in.

Fig. 1 is a front view of the nine-speed unit as finally designed. It comprises five plates 1, pivotally mounted with respect to the axis of the shaft 2. Each of these plates is capable of effecting two of the selections 0 to 9, inclusive.

Gears 3 and 4, which constitute the "pivot gears" of each ordinal transmission unit, are keyed to a common hub 5, rotatably mounted on shaft 2, as illustrated in Fig. 2, and are spaced from each other by small hardened collars upon which the plates 1 are mounted pivotally. Each of the pivot gears 3 and 4 is connected through an idler 6, rotatably mounted on a stud on the swinging plate 1, to the selection gear 7, which is similarly mounted. The reason for interposing the idler 6 is so that when plate 1 swings about shaft 2 as a center, with gear 4 held stationary, the gear 7 will be moved approximately parallel to itself and with no appreciable roll, whereas any gear that meshes directly with the pivot gear 4 will have a large amount of roll whenever plate 1 is rocked. This makes it possible to advance gear 7 into mesh with either gear 8 or gear 9, by rocking of plate 1, without causing any disturbing rotation of gear 7.

The plate 1, illustrated in Fig. 2, is the one which is arranged to effect alternatively the "8" or the "3" selection. Gear 8 is keyed to shaft 10, which extends across the machine in front of all of the transmission units and is rotated continuously at the rate of one-half turn per cycle throughout calculation. The particular gear 8, which is in line with the gear 7 illustrated, has sixteen teeth, and therefore advances at the rate of eight teeth per cycle. Gear 9 is similarly keyed to shaft 11, which continuously rotates one-quarter turn per cycle, and, since gear 9 has twelve teeth, it therefore advances at the rate of three teeth per cycle. Therefore, if plate 1 is rocked leftward, as viewed in Fig. 2, to bring gear 7 into mesh with gear 8, the train of gears 4, 6, and 7 will be driven at the rate of eight teeth per cycle, whereas if it is rocked rightward so that gear 7 meshes with gear 9, they will be driven at the rate of three teeth per cycle. If any other rate of drive is desired, one of the other plates 1 is employed, and the plate illustrated in Fig. 2 is left in the neutral position in which it is there illustrated.

Automatic Gear Shift for Nine-Speed Transmission Unit. The mechanism for effecting the power shifting of the gears to set each transmission unit automatically for its desired ratio of drive is illustrated in Fig. 3. This mechanism is controlled by a disk assembly 12, illustrated in perspective in Fig. 4, consisting of five differently shaped disks 13, integrally keyed to a gear 14, through which it is brought to a selected rotational position on shaft 15 (Fig. 5), by the manual depression of the key selected in the corresponding key row. Each of the five disks 13 (Fig. 4), control the appropriate shifting of one of the plates 1, the disk 13*a* controlling the plate which effects the 8 and 3 selections. If the 3 key is depressed, the corresponding disk assembly 12 is rotated to bring the disk 13*a* into the position illustrated in Fig. 3.

To effect the shifting of each plate 1, a pair of shifting fingers, 16 and 17, close in on the corresponding disk 13. Normally, these fingers stand retracted from the disks, as illustrated in Fig. 5. However, when any initiating key is operated, it im-

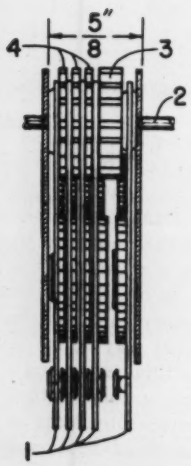

FIG. 1 FRONT VIEW OF NINE-SPEED TRANSMISSION UNIT

FIG. 2 SECTION THROUGH TRANSMISSION UNIT, SHOWING 8–3 SELECTION PLATE IN NEUTRAL

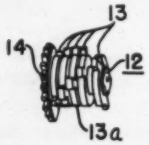

FIG. 4 PERSPECTIVE VIEW OF SHIFT-CONTROL-DISK ASSEMBLY

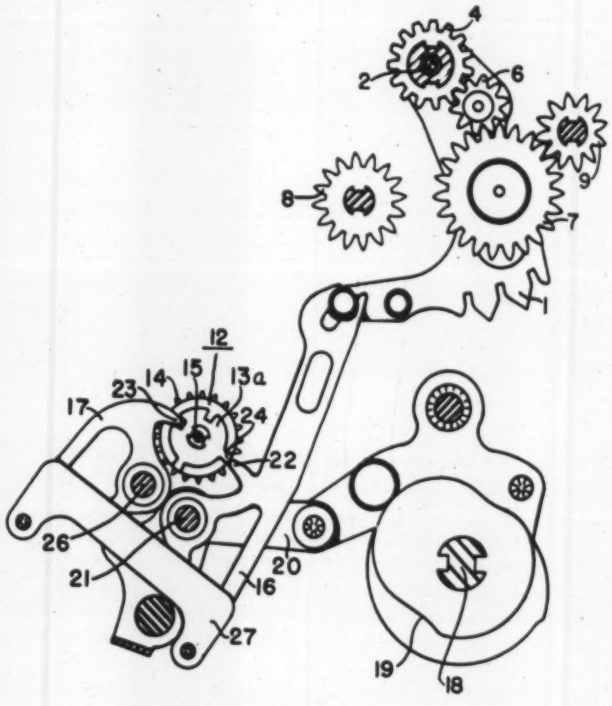

FIG. 3 SECTION OF TRANSMISSION UNIT AND AUTOMATIC GEAR-SHIFT MECHANISM EFFECTING 3 SELECTION

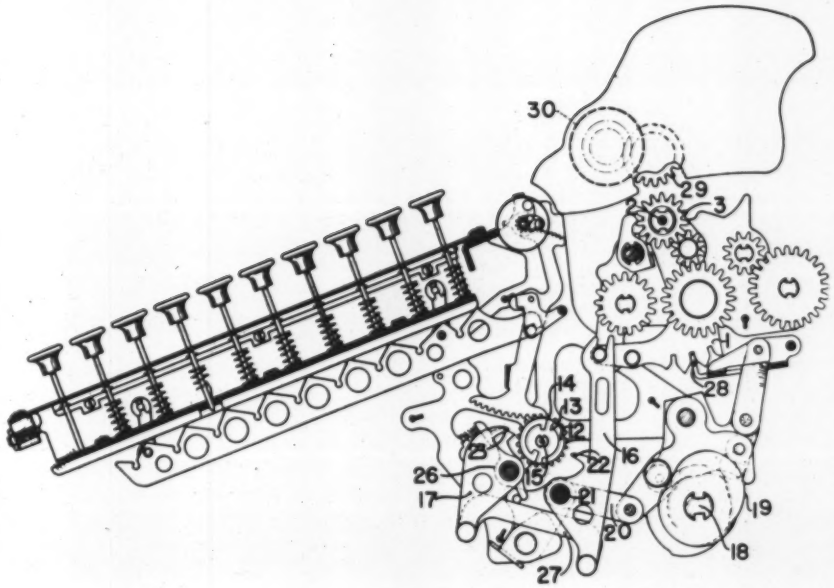

FIG. 5 RIGHT-SIDE VIEW OF A KEY SECTION, AUTOMATIC GEAR SHIFT, AND TRANSMISSION UNIT

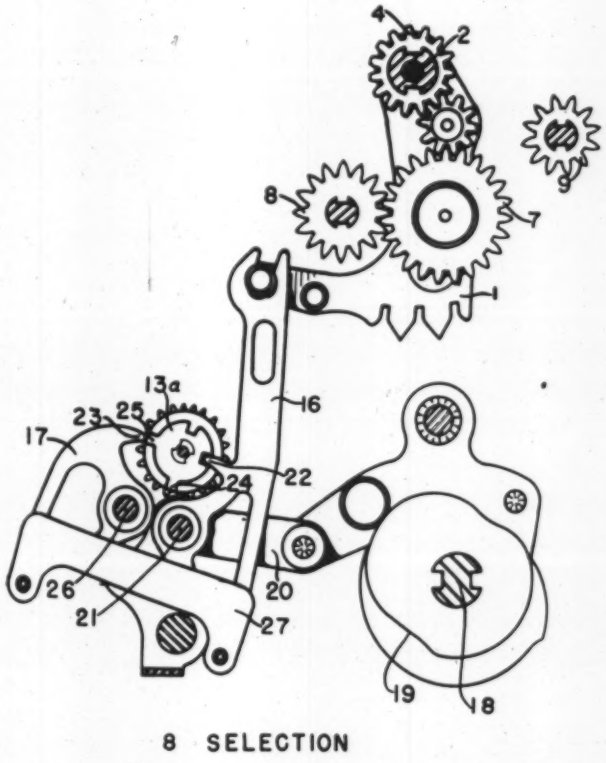

FIG. 6 SECTION OF TRANSMISSION UNIT AND AUTOMATIC GEAR-SHIFT MECHANISM EFFECTING 8 SELECTION

mediately causes setting shaft 18 to rotate through a half-turn prior to the first calculating cycle. In the first part of this half-turn, cam 19 acts through link 20 to move shaft 21 leftward, which causes the noses 22 and 23 of shifting fingers 16 and 17, respectively, to close in on disks 13. When disk 13*a* stands in its number-3 position, as illustrated in Fig. 3, a nose 24 of that disk stands opposite nose 22 of finger 16, and rocks that finger clockwise as shaft 21 moves leftward, which, through a fork-and-stud connection at the top of the finger, rocks plate 1 rightward and brings gear 7 into mesh with gear 9, thus establishing the drive at a rate of three teeth per cycle.

If the 8 key is depressed instead of the "3" key, disk 13*a* is positioned as illustrated in Fig. 6, with the nose 25 opposite the nose 23 of finger 17. This holds finger 17 counterclockwise on the fixed shaft 26, thus through link 27 and finger 16 causing leftward rock of plate 1, thereby bringing gear 7 into mesh with gear 8, which establishes a gear drive at the rate of eight teeth per cycle.

If any key other than a 3 or 8 is depressed, disk 13*a* is rotated into a position where noses 22 and 23 engage the normal circumference of the disk, thereby shifting plate 1 to its neutral position, illustrated in Fig. 2. With such a setting, some other one of the five sets of fingers 16 and 17 in this particular gear-shift unit will effect the setting of the proper gear for the selected gear ratio.

The half-turn of shaft 18, which, as previously mentioned, shifts the gears, operates also through other cams to rock the lock gate 28 (Fig. 5), down out of contact with the plates 1 prior to the time that cam 19 shifts the gears. Later in this half-turn, while cam 19 holds fingers 16 and 17 pressed firmly against the disk assembly 12, the gate 28 is rocked upward again so as to lock each plate 1 in the position to which it has been shifted.

The rotation of shaft 18 also causes the corresponding ordinal gear 29 in the shiftable carriage to rock down into mesh with gear 3, in which position it is held throughout calculation so as to transmit continuously to numeral wheel 30 movement at the rate determined by the gear ratio set up by the automatic gear-shift unit.

Compounding of Movements Produces Minute Gradations in Speed. In order to avoid the irregular movement due to previous methods of incorporating carry-over, the movement of gear 29 is not directly transmitted to numeral wheel 30, but, as illustrated in Fig. 7, a planetary differential-gear unit 31 is used to merge this movement with carry-over movement transmitted through continuously operating reduction gearing from the next numeral wheel to the right. The gear ratio is such that the carry-over gearing transmits to each numeral wheel just one tenth of the movement of the numeral wheel to its right. Since that in turn includes one tenth of the movement of the next further numeral wheel to the right, each wheel 30 is con-

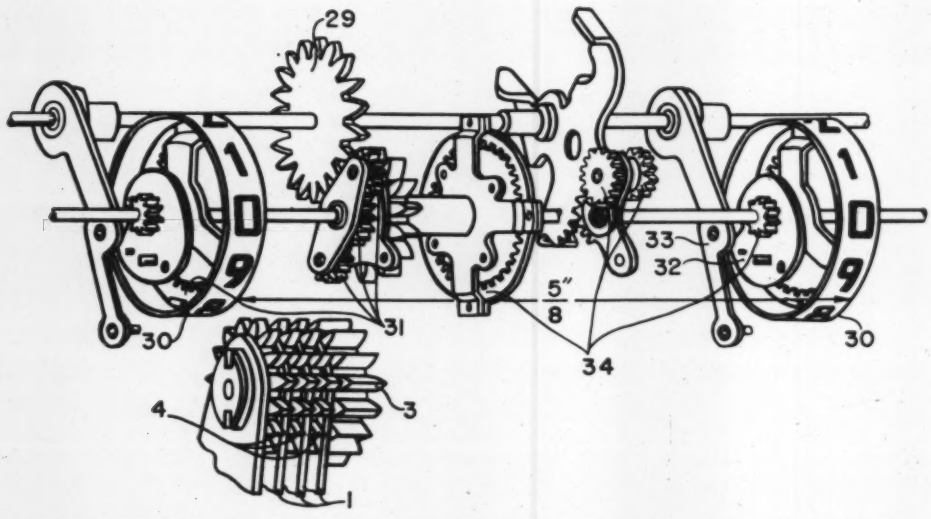

FIG. 7 EXPANDED PERSPECTIVE OF ACCUMULATOR REGISTER AND CARRY-OVER MECHANISM

tinuously and smoothly rotated uninterruptedly cycle after cycle at a rate which (measured in digital steps per cycle) is equal to the value selected in the corresponding key row plus one tenth of that in the next row to the right plus one-hundredth of that in the second row to the right, and so on. Thus if the operator has set up the amount 8375 on the keyboard, the numeral wheel in line with the number "8" key will rotate smoothly and continuously at the rate of 8.375 digital steps per cycle for any number of continuous cycles that the machine may be operated.

This attains the objectives originally outlined, but carry-over is transmitted in small fractions of digital steps. If, at the conclusion of calculation, a numeral wheel has imparted a partial carry step, that partial step must be backed out from the higher-order numeral wheel, or it would end up standing part way between its digital display positions, and not in a suitable position for reading. To take care of this, each numeral wheel is equipped with a snail cam 32, and at the close of calculation a cam follower 33 is pressed in against the snail cam and is stopped by the cam upon being rocked inward by an amount proportional to the reading of the numeral wheel, which is also proportional to the amount which should be backed out of the next higher numeral wheel 30 to bring it to its full digital position. To feed this movement to the next higher numeral wheel so as to back it up by the amount of any partial carry increment it may have received, there is interposed in the carry-over train another planetary differential-gear unit 34.

Such a train of gears, comprising these two planetary differential-gear units, is interposed in each decimal order between adjacent numeral wheels, and constitutes a continuously effective 10:1 reduction gearing to transmit carry-over movement from each numeral wheel to the next one to its left. One of these differentials serves to compound this carry-over movement with the corresponding ordinal digitation movement transmitted from the related ordinal nine-speed transmission unit, while the other differential serves to compound it with a movement which, at the end of each series of calculating cycles, backs out all partial or incompleted carry-over increments then registered by the numeral wheels and adds these same partial increments back in again at the start of the next series of calculating cycles. In line with the dimensional limitations previously mentioned, the numeral wheels are arranged on $^5/_8$-in. centers, and each complete set of ordinal mechanism described is confined within that over-all dimension.

New Types of Control Required. This smooth distribution of numeral wheel movement over the whole of each calculating cycle necessitated many changes in machine control. For instance, it became impossible to follow the previous practice of allowing time enough after the completion of each cycle of numeral wheel movement to selectively operate automatic division controls before the end of the cycle. This necessitated operating such controls during calculation instead. Snail cams 32 were therefore utilized for the additional purpose of automatically comparing the current dividend-remainder figures in the continuously whirling numeral wheels with the divisor figures on the keyboard. During automatic division, followers 33 are pressed against cams 32 and are thus continuously positioned in accordance with the current readings of the whirling numeral wheels 30, thus supplying to the dividend-divisor comparison mechanism the information necessary to effect a continuously functioning comparison division control.

CONCLUSION

The problems confronting a designer of office machines are rather intricate and varied, but they stem not so much from the difficulties of designing any particular mechanism as from the multiplicity and interrelationships of the mechanisms involved.

In portable machines such as calculators, size limitations, combined with high performance expectations, require the placing of a large amount of mechanism in a very small space. This requires the maintaining of rather close tolerances.

In view of the large amount of mechanism ordinarily involved, over-all cost considerations demand designing for low cost per unit part and prevent the use of exceptionally close tolerances. This rules out designing for the use of processes which would permit maintaining tolerances closer than 0.0005 in. and mitigates against extensive use of tolerances closer than approximately ± 0.002 in.

This has resulted in designing most of the mechanisms of such machines for production over punch presses and automatic screw machines with such tolerances as can be maintained reasonably in quantity production over those machine tools.

In designing such machines, many problems require theoretical analysis and research. Most of the designing, however, is done by careful study of shapes and movements on accurate, large-scale engineering layouts, supplemented by experimental proof and study of the various mechanisms.

An Automatic ELECTRIC FLATIRON *With* CONTROLLED STEAM

By F. E. FINLAYSON

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THE basic idea of applying steam to cloth through a flatiron is certainly not new. Patents on various arrangements can be found dating back at least as far as the beginning of this century. That the application of steam to cloth being ironed works wonders, particularly on some kinds of fabrics, none will deny, but not until the middle of the 1930's was a reasonably successful steam iron introduced for the American domestic market. Steam irons previously had been in limited use in laundries and tailoring establishments, although these were generally arranged so as to be supplied with steam through a hose from an external steam boiler.

The first electric-steam irons produced for the domestic market were of the "boiler" type, which consists of a water-containing vessel, mounted over the heated flatiron soleplate, and in proximity to it so that water in the vessel will boil within a reasonable length of time by heat conducted from the soleplate. Suitable ducts transmit the steam from the boiler to outlets on the underside of the soleplate. The iron, of course, is equipped with a conventional handle, attachment cord, temperature control, and so forth.

When the author's company decided to undertake the development of a steam iron, the boiler type was of course investigated along with others, but was not adopted for various reasons. Most important of these were (1) our belief that there is an inherent hazard in boiling a volume of water within a confined space, (2) the excessive length of time necessary to bring the entire volume of water up to the boiling point, and (3) the difficulty of controlling or regulating the flow of steam.

It was felt that if a real contribution were to be made to thee steam-iron art, an improved type of iron must be developed. After much investigation, it was decided that an iron using the "flash" type of steam generator would be the solution. Accordingly, intensive development work was commenced along that line.

Steam irons with the flash-type steam generator were not broadly new in the art, as some patents showing that general arrangement were to be found dating back many years earlier. Our problem involved the development of an improved steam iron of the type having a generator which would produce a suitable quantity of steam at a reasonably constant rate, whether ironing or steaming in air. Furthermore, the iron had to be arranged so that the steam would be entirely free of entrained water droplets which, if present, would spot certain kinds of cloth. Also, the generator had to lend itself to economical manufacture and ease of maintenance, since occasional disassembly for cleanout would be essential.

Coincident with the development of a satisfactory steam generator, a suitable means for holding the water supply had to be evolved. Several different arrangements were considered, such as a remotely mounted tank with hose feeding water to the flash boiler in the iron; an external tank on the back of the iron, reservoir in the handle, and the like. Finally, it was decided that the most desirable location for the reservoir was within the shell of the iron, although this obviously introduced the problem of limiting the flow of heat to the tank to avoid boiling in normal use. Convenient filling and controlled means of conducting water to the generator also had to be provided.

THE PREWAR STEAM IRON

By the spring of 1941 it was felt that development had been carried to the point where a satisfactory steam iron could be made, and such an iron designated F-20 was placed on the market. The internal construction of this iron is shown in Fig. 1 which is a section through the center of the iron, and top view of the soleplate and steam cover plate with the latter partly in section. Since this iron was the forerunner of the present or postwar iron, and embodied the solution to many of the fundamental problems encountered in the "flash-generator" type of steam iron, it will be described in some detail.

The soleplate with cast-in sheath-type heating element was ideal for this application. The sheathed heating element is made up of a coiled resistance wire equipped with terminals and surrounded by magnesium-oxide powder, all enclosed centrally within a steel tube which is reduced in diameter by swaging until the magnesium oxide is compacted into a dense rocklike mass. In this condition the magnesium oxide is an excellent electrical insulator and also becomes a good conductor of heat. The sheathed construction of the unit protects the electrical parts from water in the steam iron and being integral with the metal of the soleplate, makes for perfection in heat transfer.

The soleplate casting used in this iron was a hard aluminum alloy. The material was selected because of its lightness, good heat conductivity, and resistance to corrosion when properly used.

The steam generator was a cavity in the soleplate near the center, with arms extending toward the rear on either side of the thermostat seat. A cast-aluminum cover plate, held onto the soleplate by screws, enclosed the generator cavity. This cover plate was equipped with passages which lead the steam from the back of the generator forward by two parallel ducts located near the outside edges of the soleplate to the steam-outlet holes near the nose of the iron.

An all-brass water tank, designed as shown in Fig. 1, located under the conventional steel shell of the iron, was attached to the soleplate only by the thin stainless-steel drawn cup, designated as the "boiler cover." This was an important feature because the long heat-flow path through the thin high-resistance stainless steel proved effective in controlling the amount of heat going to the tank to a point where boiling would not occur under normal operating conditions.

A threaded valve bushing with a metering hole which limited the maximum flow of water connected the tank to the steam generator and held the tank in place. Flow of water through

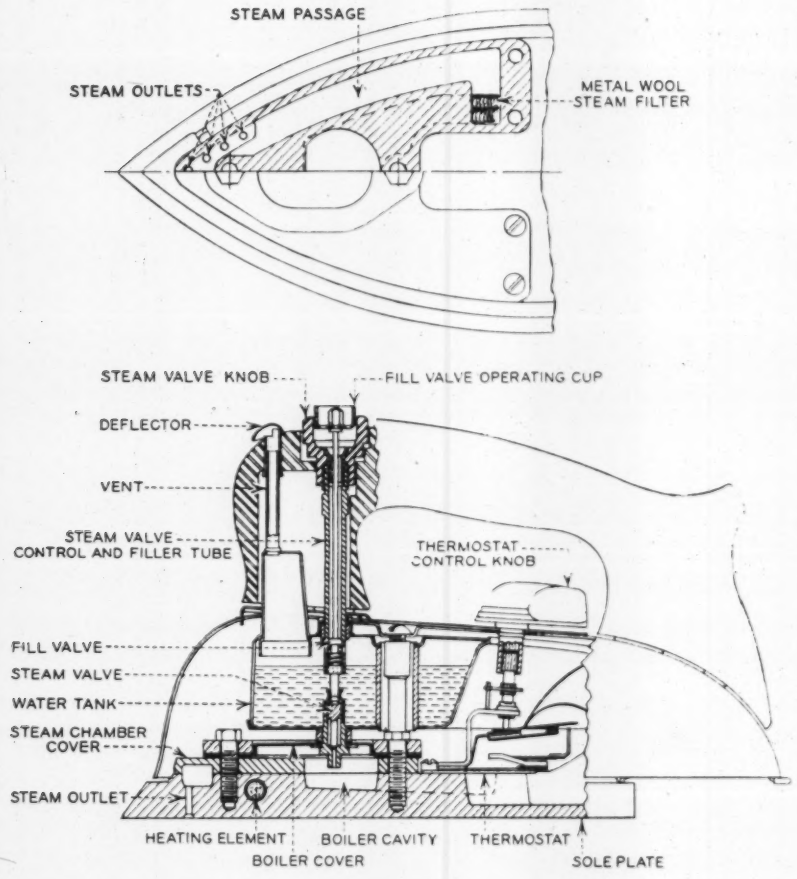


FIG. 1 SECTIONAL DRAWING OF PREWAR STEAM IRON

the valve was regulated by a modified needle, which in turn was controlled by a knob located on top of the iron handle.

The tank was filled by pouring water down through the tubular valve-control shaft. A simple automatic seal for this opening was provided in connection with the metal cup in the center of the filler opening. Thus, to fill the tank, water was put into any vessel with a pouring spout, such as a small pitcher. The spout of the pitcher was pressed against the rim of the cup in the filler opening which opened the fill valve at the bottom of the tube and allowed the water to run into the tank. When the pitcher was removed a spring closed and sealed the fill valve. This valve prevented water vapor from condensing in the filler tube and running out as hot water onto the hand of the operator when the iron was tilted back on the heel rest.

A wide open vent was provided at the front of the tank, consisting of a large riser coming up into the front-handle cavity with a smaller tube extending through the top of the handle. A small deflector cap at the top prevented any water droplets, which might come out of the vent, from coming into contact with the user's hand. The large riser tube was effective in preventing the entrainment of water with the steam which escaped from the vent in case of boiling in the tank.

The temperature of the iron was controlled by a standard thermostat, similar to the one used on other irons of that period.

To operate the iron, it was recommended that the steam valve be closed and the tank filled with water (preferably distilled). The thermostat knob was set to the proper temperature range indicated on the dial and the iron plugged into an electric outlet. After about 2-min wait, the steam valve could be opened and the iron would steam when held in a horizontal position. Steaming would stop when the valve was reclosed, and also when the iron was placed on the heel rest, because the water dropped below the level of the steam valve. In operation, water flowed through the valve in a fine steady stream which fell onto the hot soleplate cavity, and rapidly but steadily formed into steam which passed backward, first through a stainless-steel mesh filter to remove entrained water, and then forward through the hot steam passages to the outlet holes.

A considerable quantity of these irons were built and sold during the year just before the war and public acceptance was excellent. The war period of course stopped all flatiron production, including the F20 steam iron; however, it provided an excellent opportunity to study the iron under many different service conditions. The iron was generally successful. Nevertheless, as with almost any new appliance, it was felt that certain factors merited further consideration; and after the war it was decided to design an improved steam iron. The new model designated F-30 was put on the market late in 1947. It is this iron which will now be described, Fig. 2.

DEVELOPMENT OF A POSTWAR MODEL

The several years of experience with the F20 had firmly established the fact that the flash-boiler-type steam iron with water reservoir contained within the body of the iron is ideal for the domestic product. Accordingly, new development

work was done, looking toward perfection of that design, rather than the consideration of a different approach to the problem.

The first and most obvious improvement required was a reduction in size, until the product more nearly approached the appearance and dimensions of the conventional flatiron. This necessitated the reconsideration of all elements of the design from the handle to the soleplate. The result is illustrated in Fig. 3 (side-by-side view of both irons). It will be noted that a considerable reduction in the height of the iron has been accomplished. This was done without sacrificing any of the water capacity or desirable operating characteristics of the previous model.

The internal structure of the new iron is illustrated in Fig. 4. The soleplate and steam generator combination were thinned down as much as possible as part of the height-reduction program. The steam generator was designed to limit the cavity in the soleplate to a minimum, in order to increase the mass of aluminum and prevent chilling, particularly in the nose of the iron.

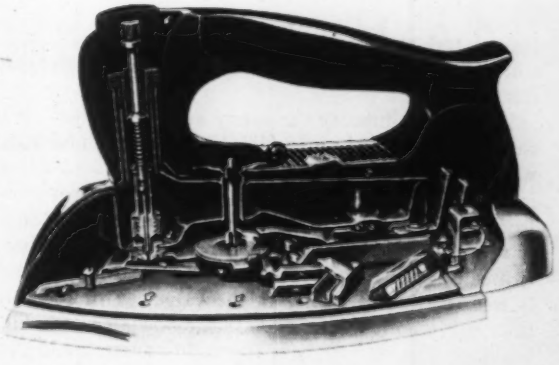
To accomplish this, a small cavity was located back near the thermostat seat and a thin metal chute was provided to conduct the water from the valve in the front of the iron back to the boiler cavity. Passages in the cast-aluminum cover plate on either side of the iron conduct the steam first backward from the boiler cavity through a fine-mesh metal filter, and then forward to the steam-outlet holes. A new layout of steam outlets was provided to give better distribution of steam over the ironing surface. The outlets open into a groove in the bottom of the soleplate. This groove is necessary to insure approximately uniform flow and distribution of steam under different ironing conditions and different types of materials. The groove allows the steam to spread out from around the holes and contact a considerable area of cloth before it starts to penetrate.

The major part of the height reduction was accomplished by redesigning the water reservoir. The tank in the new iron became part of the top itself by making the shell of solid brass and furnace-brazing in a suitable brass bottom. The appearance design was modified to make the sides more vertical which enlarged the volume under the shell without increasing the apparent size. A new thin thermostat, occupying little space under the top, was adopted, which further increased the volume available for water. This thermostat also permitted the use of a low cool-control knob, located forward under the handle, which helped the height reduction by permitting the design of a low streamlined handle.

The tank and top combination was attached to the soleplate through a thin heat-retarding stainless-steel boiler cover, which is similar to and is used for the same purposes as the one on the prewar model. A bracket was provided at the rear to help support the tank and secure the handle to the iron.

It will be noted that the tank and top unit does not contact the soleplate at any point, except at the boiler cover and bracket referred to previously. The result is that the water in the tank does not boil during any normal use of the iron at the steam-ironing temperature, which temperature is established by setting the thermostat control lever at the steam-ironing point on the dial. Experience has shown that the best steam-ironing temperature is in the neighborhood of 300 F. At this

FIG. 2 POSTWAR STEAM IRON



F.G. 4 STEAM IRON CUT AWAY TO SHOW VALVES, WATER RESERVOIR, THERMOSTAT, AND STEAM PASSAGES

F:G. 3 COMPARISON BETWEEN POSTWAR AND PREWAR STEAM IRONS

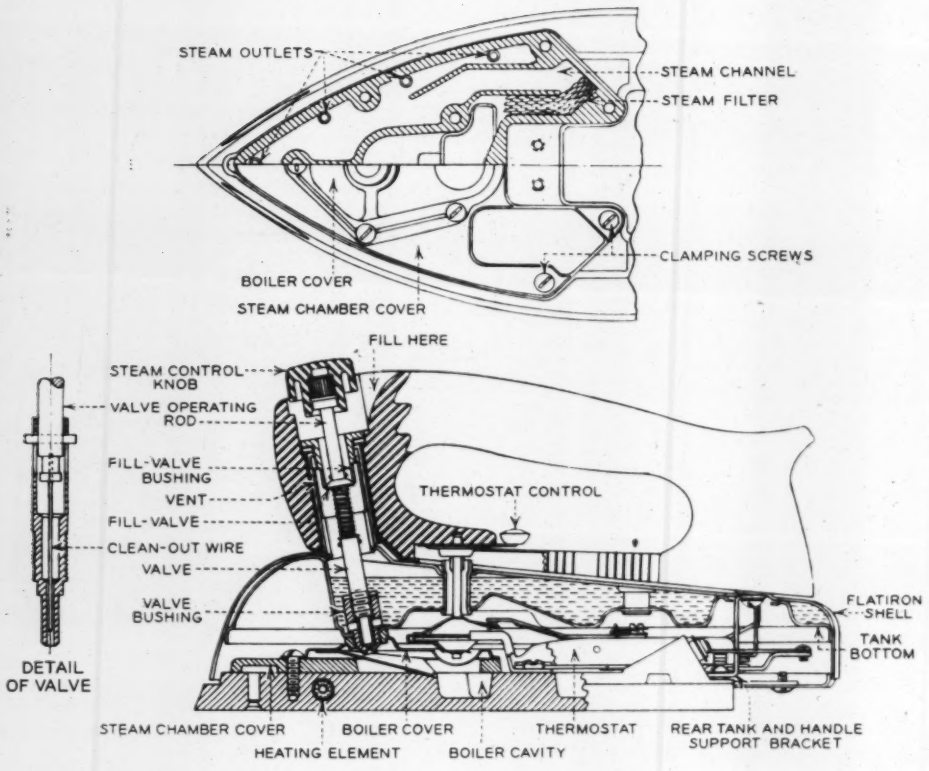


FIG. 5 SECTIONAL DRAWING OF POSTWAR STEAM IRON

temperature the steam has good wetting properties, and the soleplate is not hot enough to damage fabrics in the presence of steam.

In order to improve the safety and filling characteristics of the iron, an entirely new filler, steam valve, and vent design were developed. The new valve consists of a valve-seat bushing containing the metering orifice, which serves to hold the front end of the tank to the soleplate assembly, and into which is screwed a modified needle-type valve. The valve is controlled by a knob on the top of the handle through a rod which is free to slide vertically in the valve. This rod carries the filler valve which seats against the bottom of the filler-valve bushing, Fig. 5. A light spring normally holds the filler valve closed, but slight downward pressure on the knob opens the filler valve and allows water to enter the tank as it is poured into the cavity in the handle around the control knob. This filling arrangement is much faster and more convenient than the one used on the previous model.

The tank is still vented directly to the atmosphere, but the vent is now located at the front and near the top of the riser tube inside of the handle. Considerable clearance exists between the riser tube and the handle so that air and vapor can escape around the tube and out under the front of the handle. A metal liner protects the plastic handle completely from contact with water and steam. This construction not only simplifies the design, improves the appearance, and gives better protection to the handle, but eliminates any possibility of hot water from the vent reaching the hand of the user.

The new iron has been equipped with an ingenious automatic cleanout which prevents clogging of the steam-valve orifice by particles of dirt in the water, or by mineral deposits. The threaded valve is made with a hole extending lengthwise through it, as shown in the enlarged view, Fig. 5. Into this hole is inserted a stainless-steel wire which is only slightly smaller than the valve orifice, and which is attached at its top and to the valve-operating rod. Since this rod moves vertically a considerable distance as the fill valve is pressed to open, it follows that the cleanout wire will pass down through the orifice each time the iron is filled. Thus without being aware of it, the user is keeping the valve orifice clean and free from dirt and scale.

OPERATING CHARACTERISTICS

The operation of the iron is similar to the prewar model, except as changes in the filler call for a slightly different technique in filling the iron. The iron is designed to hold about 0.42 lb of water in the tank. The steam rate has been regulated to average about 0.015 to 0.020 lb of water per min with the valve wide open, which has been shown to give excellent steam-ironing results. Thus the iron will steam steadily for at least 25 min, and this is always extended by the amount of time the iron rests on the heel stand.

Some of the features of this product are as follows:

1 The iron is safe. Steam pressure is not and cannot be built up any place in the iron.

2 It starts steaming quickly; within 2 min after being plugged in.

3 The steam flow can be started, stopped, or regulated at will. This is a great advantage when ironing and pressing.

4 The steam flow is independent of soleplate temperature so long as it exceeds the boiling point of water.

5 Steaming stops when the iron is placed on the heel rest.

6 The iron is easily and safely filled whether hot or cold.

7 The iron is only slightly larger than the most modern conventional model.

8 It has an attractive appearance, and weighs only 4 lb.

9 The iron is equally usable as a steam or dry iron. No damage to the iron can possibly occur when operating at high heat without water.

10 The temperature control is accurate and the control lever is cool and convenient to operate.

CONCLUSION

If true progress is to be made, every development project should include two fundamental elements, namely, product improvement, and cost reduction. Some of the many product improvements involved in this redesign have been described in the foregoing. That considerable cost reduction was also accomplished is indicated by the fact that the number of parts was reduced from 91 in the prewar iron to 69 in the new model. Moreover, the arrangement of parts is such as greatly to facilitate conveyerized assembly.

FIG. 1 AIR VIEW OF GRAND COULEE DAM AND PUMPING PLANT

HISTORY *and* DEVELOPMENT *of the* GRAND COULEE PUMPING PLANT

By E. B. MOSES

HYDRAULIC MACHINERY DIVISION, BUREAU OF RECLAMATION, U. S. DEPARTMENT OF THE INTERIOR, DENVER, COLO. MEMBER ASME

THE Grand Coulee Pumping Plant is located immediately above the Grand Coulee Dam on the Columbia River in the central part of the State of Washington. The dam impounds water for the Columbia Basin Project which will bring under irrigation an area of 1600 square miles.

The first survey of the Columbia Basin Project was made by the newly formed Bureau of Reclamation in 1903. Later investigations were made by the State of Washington and the Bureau in 1914-1915, and by the Columbia Basin Survey Commission in 1919–1920. For some time there was a controversy over the method of supplying water to the project, whether by diverting water from an upstream tributary of the Columbia and carrying water to the irrigable lands by a system of gravity canals, or by constructing a dam across the Columbia and pumping water into the basin, utilizing a portion of the power available at the dam for this purpose. The Army Engineers made a thorough investigation of this problem in 1927–1931, and in their report to Congress in 1932 the advantages of the pumping scheme over the gravity-flow scheme were clearly demonstrated and led to the adoption of the present project plan. In 1933 the Bureau of Reclamation was authorized to proceed with the construction of the Grand Coulee Dam. Initially a low dam was to be built from emergency funds for power development only, with provisions for raising it to its maximum height at a later date to enable water to be pumped for irrigation.

Due to prolonged drought in the dust-bowl area of the Missouri River Basin, thousands migrated to the Pacific Northwest and the resulting demand for good farmlands made the ultimate development of the Columbia Basin Project a matter of urgency, and in 1935 the Secretary of the Interior issued an order for constructing the dam to its full height. Power was first developed in October, 1941, and the dam was completed in 1942. During the war and since, additional generating units were installed as fast as they could be delivered, as the demand for power due to the war activity was so acute that all possible generating capacity was required to supply the industrial power requirements. After the war, work on the irrigation features of the project was resumed, of which the Grand Coulee Pumping Plant is the primary feature since this plant will eventually supply all the water for more than 1,000,000 acres comprising all the irrigable land within the boundaries of the whole project.

DESCRIPTION OF PUMPING PLANT

The pumping plant is essentially an integral structure with the dam, and includes a concrete building 602 ft long lying at an angle of 67 deg with the dam axis on the left or west bank of Lake Roosevelt which is the 152-mile-long lake formed by

Contributed by the Hydraulic Division and presented at the Semi-Annual Meeting, San Francisco, Calif., June 27–30, 1949, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Abridged.

Grand Coulee Dam. The pumping-plant dam is a gravity-type concrete structure having a height of 160 ft and a length of 612 ft joining the main dam near its left abutment. The pumping plant isl ocated between this dam and the rock cliffs west of the lake, as shown in Fig. 1. The pumping-plant dam and foundation for the pumping plant, together with the sloping 18-ft-diam tunnels through the cliffs for the 12 discharge pipes, were constructed at the time the main Grand Coulee Dam was built.

The pumping plant is provided with 12 bays for the 12 pumping units spaced on 45-ft centers. An additional bay is provided for the erection and servicing of a single unit. Two 100-ton traveling cranes will serve all bays. Each pumping unit consists of a vertical-shaft single-stage centrifugal pump connected by flange couplings to a 65,000-hp 200-rpm 3-phase 60-cycle 13,600-volt unity-power-factor synchronous motor located above it. Fourteen-foot-diameter suction pipes constructed in the dam and 14-ft × 7-ft 2-in-diam accelerating-velocity elbows conduct water from the lake to the eyes of the pump impellers. The upstream end of the suction pipes have a bellmouth transition to the face of the dam to reduce intake loss to a minimum. Hydraulically operated roller gates, 13 ft wide × 20 ft high, are provided to seal off the suction line when it is desired to unwater a unit for inspection or repair. A semicircular trashrack structure for each pump intake extending up above maximum lake level provides protection against debris being drawn into the pump. The pump is connected to the 12-ft-diam discharge pipe by means of a 3-deg-taper diffuser section 61 ft long. The profiles of each pipe are slightly different due to topographic conditions. The total length from center line of pump to discharge end of siphon varies from approximately 977 ft for Unit P-1 to 738 ft for Unit P-12. Each pipe ends in a 12-ft-ID concrete siphon, discharging into the main feeder canal as shown in Fig. 2. All siphons are combined into a single concrete structure, the discharge ends having a transition section from 12 ft in diam to a rectangular section 12 ft $4\frac{1}{2}$ in. wide × 16 ft 5 in. high. A single 30-in-diam air valve at the top of each siphon is provided to break the siphon and stop backflow from the canal upon power failure.

SIPHON AIR VALVE

Fig. 3 is a diagram of the 30-in-diam air valve with its operating mechanism. Two air-compressor units with receivers furnish air to the two accumulators which are partially filled with oil. On power interruption to the pump motor, the four-way oil valve is moved by solenoid control so as to admit oil to the top of the piston which will positively move the 30-in. air valve to the open position and break the siphon. The air valve is a double-seated balanced valve with rubber seats, one valve being furnished for each of the 12 siphons. The 12 valves are operated from the centralized oil-pressure system. The accumulators are charged alternately, one acting as a sump for the system, oil level being controlled by floats. Oil is used in preference to air for the operating medium to prevent freezing of the air valves which are not housed in.

The air-valve control system is designed to prevent high reverse speed in the pumping units as well as to prevent loss of water from the canal each time the pumping unit is taken out of service.

The water surface of Lake Roosevelt will vary from a minimum at an elevation of 1208 ft during low river discharge to a maximum at an elevation of 1290 ft during high water, a varia-

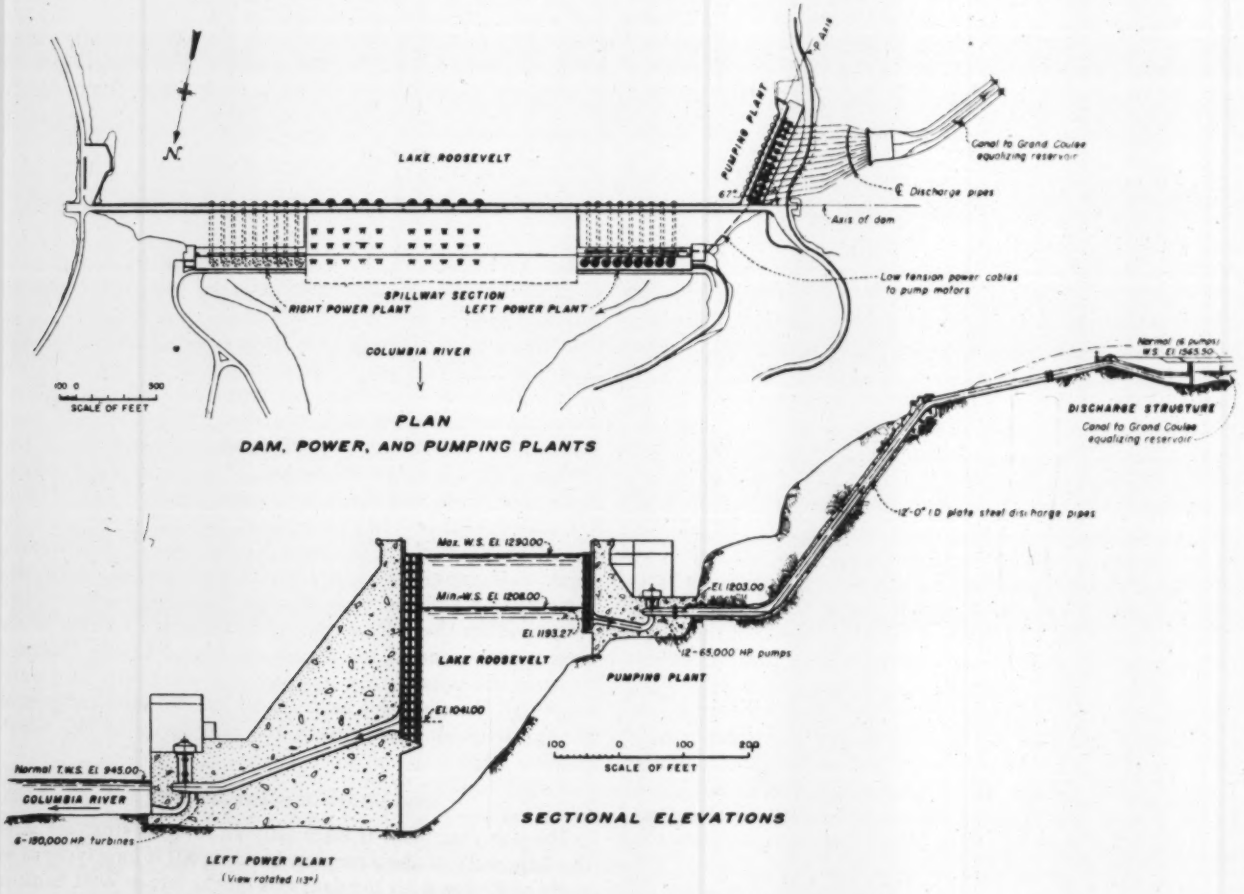


FIG. 2 RELATIONSHIP OF HEADS ON TURBINES AND PUMPS

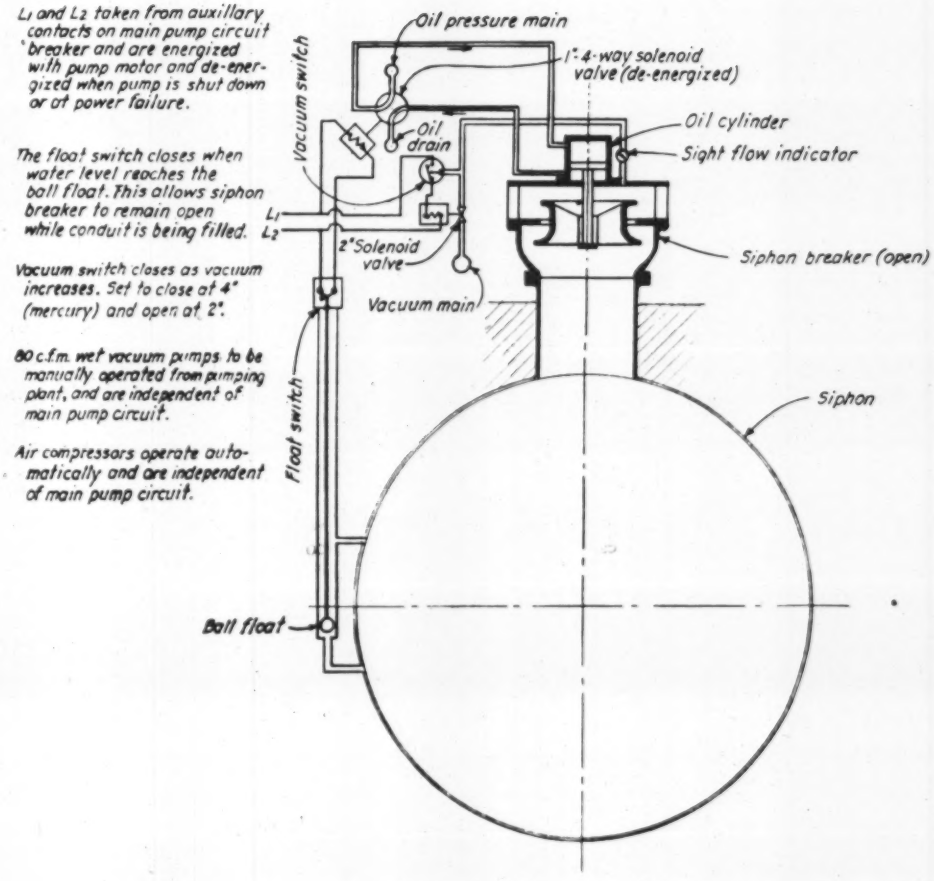

L1 and L2 taken from auxillary contacts on main pump circuit breaker and are energized with pump motor and de-energized when pump is shut down or at power failure.
The float switch closes when water level reaches the ball float. This allows siphon breaker to remain open while conduit is being filled.
Vacuum switch closes as vacuum increases. Set to close at 4" (mercury) and open at 2".
80 c.f.m. wet vacuum pumps to be manually operated from pumping plant, and are independent of main pump circuit.
Air compressors operate automatically and are independent of main pump circuit.
Oil pressure main
1" 4-way solenoid valve (de-energized)
Oil cylinder
Sight flow indicator
Oil drain
Vacuum switch
L1
L2
2" Solenoid valve
Siphon breaker (open)
Vacuum main
Siphon
Float switch
Ball float

FIG. 3 DIAGRAM OF 30-IN. AIR-VALVE CONTROL

tion of 88 ft, Fig. 2. The center line of the pump is at an elevation of 1203 ft. This location gives a minimum submergence of 5 ft which should prevent any cavitation under the most severe operating conditions. The crest of the siphon inverts are at elevations which vary slightly due to the angularity of the plan and profile projections of the pipe line, varying from 1569.94 ft to 1571.01 ft. The elevation of water surface in the feeder canal to the equalizing reservoir will vary from 1553.5 ft with one pump operating to 1570.0 for a maximum discharge of 16,000 cfs. Including pipe friction, etc., these elevations result in a total dynamic pumping head which will vary from 270 ft minimum to 365 ft maximum, the rated head being 310 ft at which point the guaranteed discharge is 1350 cfs.

From the siphons, water flows through the 1.6-mile-long feeder canal to the equalizing reservoir. The siphon outlets are completely submerged at the minimum canal level to insure priming when only one pump is operating. The equalizing reservoir is formed by the North and South Coulee Dams. It is 26 miles long, has an area of 40 sq miles at maximum water-surface elevation of 1569.94 ft, and has a storage capacity of 1,200,000 acre-feet, of which 700,000 acre-feet is live storage. During the period of maximum irrigation demand, this reservoir will be drawn down to its minimum level even with all pumps in operation.

PRELIMINARY INVESTIGATIONS

In pumps of such unprecedented size, over-all efficiency and smooth operation at all heads assume such importance that every feature of the plant involving hydraulic problems from the trashrack intake structure to the siphon outlet were investigated by means of model tests. Hydraulic model studies were made in the laboratory of the Bureau of Reclamation on all features except the pumps and an extensive research program was carried out during 1938–1940 in the Hydraulic Machinery Laboratory of the California Institute of Technology to develop and verify the pump design together with the design of the intake and suction elbow. The need and justification for these elaborate preliminary tests may be appreciated when we compare the 65,000-hp motors which will drive the Grand Coulee pumps with the 12,000-hp motors used on the most powerful of the units now operating on the Metropolitan Water District of Southern California, which up to this time are the largest pumping units as regards power built in this country. There are several European pump storage plants with pumping units up to 35,000 hp, but the ultimate installation of 780,000 hp in the 12 motors at Grand Coulee far exceeds any pumping installation at present in existence or likely to be constructed for some time to come, and justified the most thorough preliminary investigations.

MODEL TESTS

The preliminary designs of the pump as furnished by several manufacturers indicated that a prototype speed of 150 rpm would be required. This resulted in a large pump having an impeller diameter of approximately 218 in. with a correspondingly large casing and a specific speed of approximately 82. From the tests on the preliminary models, it was found that the prototype speed could be safely increased to 200 rpm with a reduction in impeller size to 168 in. and a corresponding increase in specific speed to 103.

The size of the pumps was determined by the capacity of the main generating units at Grand Coulee. The first six units are rated at 150,000 hp, this being the largest unit practicable to build at that time. Limitations of forging practice and foundry equipment and the permissible clearances on railroads were all factors which established the size and capacity of the generating units. The size of the pump is based on the assumption that two pumps will be operated from one generator isolated from the remaining units and at minimum head on the turbine.

From the final model tests made at the California Institute of Technology, the expected characteristics of the prototype pump have been calculated. At the rated head of 310 ft, the discharge is 1450 cfs and at the minimum head of 270 ft the discharge is 1630 cfs, while the maximum brake horsepower will be 60,100, well within the rated capacity of the motor. The shutoff head is 422 ft. While no valve of any sort is located in the discharge line, this head is of interest as indicating the maximum pressure that can be produced at normal speed in the remote possibility of the siphon being completely sealed by ice at the time of starting up the pump.

OPERATION AT INCREASED SPEEDS

Computations were made to ascertain the power requirements of the pump and the power output of the prime mover when electrically connected and operating at some speed above the normal speed corresponding to 60 cycles. It was found that at normal lake elevation of 1288 ft and normal tail-water elevation of 945 ft, the prime mover when electrically connected to two pumping units will be able to operate at $\alpha = 1.083$ or $1.083 \times 60 = 65$ cps, at which time the pump would deliver 1885 cfs under the discharge head corresponding to 1288 ft intake water surface.

OPERATION UNDER VARYING HEADS

The horsepower input required for two pumping units and the horsepower output of one generating unit when operating over the full range of reservoir elevations, show that at low reservoir elevation nearly the entire generator output will be required for operating the two pumps, while at maximum reservoir elevation of 1290 ft there is an excess of 53,000 hp over that required for two pumps. This excess power may be delivered to the power system or may be utilized by increasing the normal speed of the generator-motor combination with corresponding increase in pump discharge. The pump horsepower will increase approximately as the cube of the speed.

GENERATOR RATING

The first six units installed in the left powerhouse, Nos. L-1 to L-6, have been assigned for operation of the pumps. They are rated at 108,000 kva, unity power factor, 120 rpm, three phase, 60 cycle, 13,800 volts. They are provided with separate 250-volt exciters driven by synchronous motors to provide excitation during reduced-speed starting of the pump motors. The capacity of the unit will vary from a minimum of 80,000 kva at low lake levels to a maximum short-time overload of 135,000 kva at the maximum lake level.

MOTORS FOR PUMPS

The motors for the pumps are similar in design to a hydraulic-turbine-driven generator of comparable capacity. The rotors are equipped with amortisseur windings which permit starting as induction motors at reduced voltage. Each motor is enclosed in an air housing and cooling is effected by cooling coils through which 900 gpm of water is circulated. Table 1 gives data on the pumping units.

The synchronous motors are rated at 65,000 hp, unity power factor, 60 cycles, 3 phase, 13,600 volts, 200 rpm. Each motor is provided with a separate 250-volt 1200-rpm exciter, as described in Table 1.

TABLE 1 PUMPING-UNIT DATA

	Units P-1, 2	Units P-3, 4, 5, 6
Motor WR^2	17,000,000	18,153,000 lb ft^2
Pump WR^2 with casing full of water	1,900,000	1,900,000 lb ft^2
Motor weight, complete	680,000	690,000 lb
Pump weight, complete	418,000	418,000 lb
Motor, rotating parts	330,000	348,500 lb
Pump, rotating parts	99,000	99,000 lb
Thrust-bearing capacity (0–147.5 per cent speed)	630,000	684,000 lb
Breakaway torque from rest	30,000	30,000 lb ft
Exciters:		
Motor, 6900 volt	300	200 hp
Main exciter	175	125 kw
Field exciter	5	3 kw

The size of the pumps and motors required considerable study to determine the most suitable method of starting. Consideration was given to the use of 60-cycle reduced-voltage starting, but as this method involved excessively high currents and high stresses in the windings of the connected machines, it was discarded in favor of a scheme in which the one or two motors will be started by a single generating unit at less than normal voltage and frequency. During normal operation, two motor-driven pumps will be connected directly to one generating unit through a generator-voltage air-insulated metal-enclosed bus with each conductor in a separate nonmagnetic housing. The average length of these buses will be about 1200 ft. No transformers are used between prime movers and pumping units, and the bus loss will be of the order of 1 per cent of the motor input.

The pumps may be started by either of the following two methods:

1 The synchronous method. The motors are direct-connected to the generators at zero speed and then brought up to normal speed in synchronism.

2 Induction-motor method. The motors are started as induction motors with the generating unit at reduced speed, when the motors are pulled into step with the generator and the three units then brought up to normal speed together.

To guard against high pressures, a pressure relay on the pump and an overspeed trip on the pump motor are provided to disconnect the pumping unit on excessive overspeed so as to limit the pressure rise in the pump casing to 210 psi, the test pressure on the casing being 315 psi.

IRRIGATION AND POWER REQUIREMENTS

Hydrographs of the Columbia River taken over a period of years indicate a fairly constant flow of some 75,000 cfs from January to April, then rising to 500,000 cfs in early June, gradually rounding off to 300,000 cfs in August to 100,000 cfs in September. It is thus seen that maximum river flow corresponds closely to the irrigation season. This fact is favorable for the operation of the pumping system. The generators assigned to irrigation pumping will be available for commercial service during the nonirrigation periods. By resorting to intermittent pumping, these generators may also be used to meet daily peak demands even at the height of the irrigation season. Pump operation will be integrated with the general power requirements as much as possible so that the minimum of interference in power demands will occur. The pumping units may also be operated at synchronous speed from the power network, including both hydro and steam-generating plants.

(Continued on page 740)

PRESERVING LIBERTY

Effective Communication as a Means Toward Maximum Production While Preserving Individual Liberty

By W. C. BEEKLEY

THE WHITLOCK MANUFACTURING COMPANY, HARTFORD, CONN. MEMBER ASME

IT would seem that the fundamental quality of the great problem which now faces us is that of preserving individual liberty within an economic and social framework which has become exceedingly complex and promises to become still more so. In connection with this problem, I would like to direct attention to the significance of communication within a single economic unit—a company.

Since any "company" or "business" is essentially a rather tightly integrated, functional organization of individuals, any common achievement can be accomplished to best advantage if each individual member conforms to two requirements:

1 He or she sincerely wishes to assist in achieving the purpose.

2 He or she apprehends clearly how his or her individual function may be applied most effectively.

In every organization there are a few individuals whose principal responsibilities are planning, and, from this point, stem the plans upon which are based the accomplishments of the organization as a whole. It is in the communication from these men to all the other members of the organization that the essential problem lies.

HOW COMMUNICATION CAN BE EFFECTIVE

In order that communication may be effective, it must set forth the whole problem thoroughly. It must explain not only the things to be done, but the reasons for doing them. Particularly, it must show conclusively that the final goal can only be achieved by a common effort in which each should take his part, in which the achievement of each advances the individual interests of all others, and the failures of each hurt all others. Obviously, when expressed in these terms, it is not a "one-time" effort but a continuous program. The lines of communication must be built steadily and the whole plan developed consistently. The possible means of communication are many, each having its own particular values, and applications, but only certain general considerations will be mentioned.

Communication in many organizations has been either haphazard, or confined within a strait jacket of convention, or both. If we are to make it effective, I believe the first thing we must do is to clear away the rubbish which has accumulated and lay a sound foundation. This will require some tough thinking and courage. I realize that I am not the first to tackle this problem, nor the only one who is struggling with it now, but as I view it, there are three prime factors to keep in mind if we are to solve this problem effectively:

1 We must choose carefully the ground upon which we are going to fight, for this is a fight, a fight against an apparently spreading acceptance of attractive but fundamentally false and mischievous doctrines which threaten the very existence of our liberties and all that we have achieved.

2 We must sift the problem thoroughly to determine exactly what are the fundamental principles to which we must hold and upon which our communications must be based, confine ourselves carefully to these principles, and pound away at them.

3 We must express these principles, in so far as possible, in self-explanatory and unequivocal terms.

CHOOSING OUR GROUND

By choosing our ground carefully, I mean that the true liberals (those who want to see more real liberty rather than less, as a foundation for still further progress, and a means for still greater good to the greatest number) have allowed themselves to be forced onto grounds where the ultimate defeat of liberty is almost inevitable.

One feature of these grounds is the implicit acceptance of relatively large and powerful groups or blocs as a means of shaping our economic and social development. I submit that so long as we use such terms as "labor" and "management," we are accepting this basis implicitly. As I see it, this is a direct contradiction of the principle of individual human liberty and dignity.

Another feature of these grounds is the acceptance of the idea that all communications to labor must be either contentious or paternalistic and sugar-coated, must express the alluring ideas of security, of flush and easy living without struggle; in other words, that those to whom these communications are addressed are children who must be cajoled by means of candy sticks and whose thinking we must do for them—in a farseeing and paternalistic manner.

This to me seems not only insincere, but hopeless. We can never hope to contend, in making "promises," with the vague theorists who would turn back the clock to a "perfectly" controlled, paternalistic system in which all will be sweetness and light. These theorists have captured every alluring slogan so far in the battle of words, and apparently will continue to do so, unless we forge a new approach to, and a new vocabulary for, the expression of the responsibility of free men and women for the development of their economic and social environment.

I submit that thinking is everybody's business and that communication should be so worded as to stimulate everyone to think—not to do their thinking for them.

BASIC PRINCIPLES

Now what of basic principles? The most important of these are well expressed, either explicitly or implicitly, in our Declaration of Independence, in our Constitution, and in our Bill of Rights. I would like to express the essence of these briefly in terms of how men should work with each other toward a common end:

The recognition of each as an individual, implying complete individual liberty in thought, word, and deed.

The responsibility of each to all the others, as partners in a

Contributed by the Management Division and presented at the Spring Meeting, New London, Conn., May 2-4, 1949, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

common effort. (These two are fundamental and from them are derived, more or less directly, the others.)

A consciousness of the desire for recognition of achievement, unselfishly accorded.

Consciousness of the desire of each for a "place on the team," from which flows loyalty—not loyalty to that vague entity "The Company," but loyalty to all the others engaged in the common effort.

A clear and conscious recognition of those mechanisms which experience has taught us are necessary among a free people to insure continued progress.

The principle of competition, a stern and rigorous requirement, but fundamentally rooted in human nature.

The principle of graduated material rewards in proportion to the individual contribution to the common effort—in other words, incentives.

The principle of the inviolable right to accumulate and retain property individually.

As our economy has developed into a highly complicated and closely integrated structure, this has resulted, naturally among a free people, in modern "capital," that is, relatively large single units of property, owned in common by a group, voluntarily associated, and devoted to a common purpose. Thus we approach the use of capital as the most effective means so far devised by man toward the greatest material good for the greatest number—not as a slogan.

EXPRESSION IN COMMUNICATION

Now we come to the matter of actual expression in communications—this business of "semantics." We are attempting to communicate ideas by means of words. Unfortunately, words are inefficient and uncertain means for expressing ideas, but they are the only relatively quick-acting tools we have for this purpose. They should be chosen with great care. I submit, as worth consideration, a careful examination of many of the words which we habitually use in communication in connection with economic matters. It is my conviction that many could well be discarded because they do not express accurately the really significant values in our economic system; or they have acquired invidious associations which defeat their usefulness, or both.

Specifically, I question the following, among many:

The use of the terms "labor" and "management." I believe that our achievements have been built on the foundation of complete individual liberty, and that we can continue to achieve only if each economic unit is truly a voluntary association of individuals, organized on a functional basis. The acceptance and use of a term which implies a continual contest (internal with regard to any given economic unit) between two power blocs is, to me at least, repugnant, and I believe it is destructive.

"Capitalism" is another term which, it seems to me, has outlived any usefulness it may once have had. It fails to express the one indispensable characteristic of our economic system, which is "competition." If we lose the competitive nature of our system, we lose all that has made it great and has resulted in the greatest good for the greatest number.

"Free Enterprise" is, perhaps, slightly more effective and useful but fails, I think, to express clearly to most men the essential characteristic to which we must hold.

PLANNED ECONOMY

Now, just for contrast, let me take that alluring phrase, the "planned economy." Here my point of view is the same but the application is inverted. You simply cannot argue many, perhaps most, of the people out of accepting it as representing something pretty fine. It is my opinion that there has been too common a tendency, on the part of men speaking for "industry," to say, in effect: "We will have none of it." Here is a place, I think, where we are actually refusing favorable grounds for battle against fallacious doctrine. It would seem that the very essence of the material success of our economy is that it has been a planned economy, conspicuously so during the last two or three generations; and that the marked change in the tempo of industrial development during the last two generations has been due, in large part, to improvements in the technique of planning. Not only has this development constituted a great technological improvement but the brilliance of it captures the imagination; vast plans, exciting and breath-taking plans, carried to success and flowering and bearing fruit in ever-better living.

But—here is the point to emphasize—it has been planning by real experts, men whose functions in our economic units were planning, trained in the profession of planning, tried and proved by the competitive system. They have been constantly and immediately answerable to the people, their rewards or punishments have come quickly and conclusively and without favor.

When their planning was right, they were generously rewarded, but the benefits to society were incalculably greater. When their planning was wrong, a few people suffered with them, but Society as a whole did not suffer significantly.

Do we want to have this extremely important function of planning captured by a system under which its quality and effectiveness inevitably will deteriorate? And if not, are we pursuing the best course in practically playing down the importance of planning, rather than emphasizing the competence, flexibility, and actual brilliance of our present system—and the fact that it is constantly and effectively within the control of the people as a whole?

This whole subject is becoming continually more important when viewed against the background of our national scene. It has become increasingly clear during the last few years that now, or soon, we may be facing a crisis that is almost without parallel in our history. Steadily and relentlessly, and with amazing speed, we have seen the spread of at least apparent acceptance of a doctrine which is so entirely and fundamentally opposed to the principles upon which this country was founded, and upon which our achievements have been based, that it would be inconceivable if we had not seen it happening before our eyes. Consideration of this danger leads to two significant thoughts:

In the planning and execution of communication, we cannot ignore the fact that no one economic unit stands entirely by itself. The effectiveness of communication in any one unit inevitably is influenced by the current of communication from exterior sources and the impact of events in our country, and in the world. In that respect, those of us who are engaged in "small business" frequently feel that we are being ground between the upper and nether millstones.

However, if we are to resist this tendency to turn back the clock, no effort is so small as to be insignificant or not worth attempting, and here, I believe, is the opportunity of the small plant. In the small plant we still have, if we will use it, quite effective man-to-man contact. Perhaps, therefore, a great part of the responsibility for maintaining our liberties and the essential qualities of our economic system, which has developed, characteristically, within the framework of those liberties—and for insuring further progress toward the greatest good for the greatest number—lies with the small plants.

CLOSE CONTACT WITHIN ORGANIZATIONS ESSENTIAL

Toward this end I suggest the continuous use not only of

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SOME RECENT DEVELOPMENTS *in* BURNING WET WOOD

By OTTO DE LORENZI

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THE continuing high-level costs of coal, oil, and natural gas have stimulated the development of improved burning methods and furnace designs for use with many so-called refuse fuels. In a large number of different industries the quantity of by-product fuels available is sufficient to furnish part or all of the steam needed for process work and power generation.

Perhaps the most widely available refuse fuel is some form of wet wood. In this paper wood containing above 30 per cent moisture, on the as-received basis, is considered as "wet."

Wet wood is a large-quantity by-product to the manufacture of lumber, pulp, and the so-called naval stores such as pine pitch and resin. When used for steam generation it falls into three broad classifications, each of which has its own specific combustion problems. Into the first classification fall the sawmills in which much of this fuel is produced. For their own use, it is usually made up of sawdust, shavings, bark, and other wood waste in varying percentages depending on the nature of the operation, resulting from the production of lumber, the method of storing and disposing of waste wood, and the arrangement of available fuel-burning equipment. A subdivision of this classification consists of those plants which purchase their wood-fuel supply, called "hog fuel," usually composed of chips with little or no sawdust and shavings. Pulp and paper mills are in the second classification, as they must dispose of wet-wood refuse produced in their wood-preparation plants. Their principal problem is one of wet-bark disposal. The third classification is composed principally of the so-called naval stores plants the majority of which are located in the southeastern section of the United States. In these, pine pitch, resin, and other products are obtained from pine stumps which are chipped, mixed with a solvent, and steam-cooked. The "spent" wood-chips, minus the recovered pitch and resin, are then available for steam production.

For lumber-mill installations the furnace most frequently used is of the two-stage type comprising a Dutch oven for drying and gasification and a secondary chamber in which combustion of the gaseous products is completed. Inasmuch as wet-wood burning is largely a matter of surface combustion, the use of refractory arches and walls in the primary or Dutch-oven furnace is of considerable importance. Their function is to provide the maximum possible amount of radiant and reflected heat for maintaining gasification and preventing the fire from becoming extinguished, even though the overfeeding principle of continually supplying fresh fuel to the surface of the ignited cone-shaped pile is used.

Dutch-oven installations operate quite successfully but are subject to frequent service interruptions such as cleaning slag accumulations, and refractory or grate renewals. Furthermore, because a large percentage of the air for combustion is noncontrollable, and the fuel supply cannot be closely regulated, it becomes necessary to make continual changes through manual adjustments to produce acceptable operating results.

A considerable amount of experimental work has recently been completed with a design that provides what may seem to be a radical departure from previously accepted standards for wet-wood burning. With this newer approach it is possible to simplify furnace arrangement, reduce width of boiler furnace, and bring many previously noncontrollable factors of older designs to a point where automatic regulation will replace most of the previously required manual adjustments.

The experimental installation consists of a single-stage furnace 20 ft high, in the lower part of which is installed a grate 8 ft wide × 8 ft long. Wet wood is supplied by the underfeed method to the grate through a specially designed retort. A reciprocating ram moves the wood from a hopper or bin through the stoker conveyer pipe to the retort. The fuel is burned in a pile, but instead of being continually showered downward from above it is gradually forced upward through the pile from the retort. The fuel feed is thus definitely controllable and the external stoker hopper serves as a surge bin to take care of variations in wood supply from the conveyer. Air for combustion is supplied under grate as well as overfire by a forced-draft fan. There are no openings through which large noncontrollable quantities of air may flow into the furnace. Thus with this design it is possible to apply automatic regulation, for maintaining desired proportions of fuel and air and thereby maintain more consistently uniform operating conditions.

Some of the data from this experimental installation are shown in Table 1.

TABLE 1 RESULTS WITH UNDERFEED FIRING OF WET WOOD

Fuel	Moisture, per cent	CO_2 per cent	Lb per hr	Lb per sq ft per hr
Southern pine and sawmill refuse	51.4	17.5	7500	117
Southern pine and sawmill refuse	51.4	17.0	12750	200
Spent pine chips	66.5	16.0	13150	206[a]
California redwood	54.0	16.9	11200	175
California redwood	50.9	15.7	10930	170
California redwood	57.8	18.8	15300	240[a]
California redwood	49.1	17.3	14550	227
California redwood	57.8	15.6	7880	123

[a] Limit set by burning rate.

The possibility of burning wet wood in a single-stage furnace, at continuous rates of from 200 to 235 lb per sq ft grate per hr, with CO_2 approximately 17.5 per cent, provides the designer with a number of interesting possibilities, when new installations are considered. The wood-burning stoker and grate would be used with a water-cooled single-stage furnace serving as an integral part of the boiler. Economizer and air heater could be used to provide higher efficiency through additional heat recovery. The amount of steam produced per foot of width with the new unit would be greater than with previous designs. The result would be a highly efficient, compact, automatically regulated unit capable of operating for long continuous periods between maintenance or cleaning outages.

Contributed by the Fuels Division and presented at the Semi-Annual Meeting, San Francisco, Calif., June 27–30, 1949, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Slightly condensed.

Many of these design features are incorporated in the unit shown in Fig. 1.

The foregoing discussion may also be applied to those plants which purchase their wood-fuel supply. The operating problems, however, are somewhat simplified because moisture, as well as chip and sawdust content of their fuel may be more

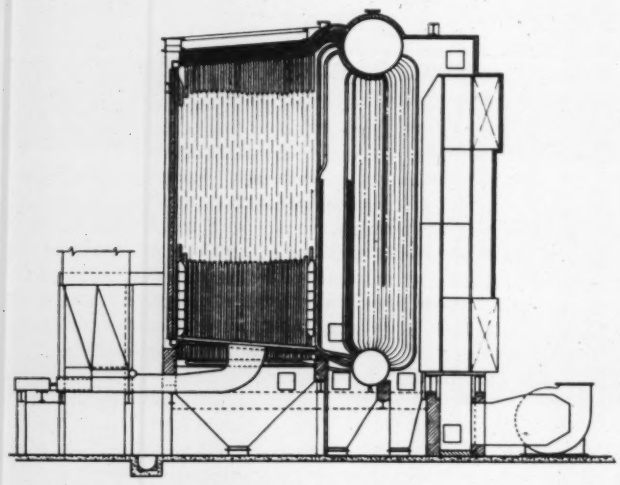

FIG. 1 A STEAM-GENERATING UNIT WITH SINGLE-STAGE FURNACE USING THE UNDERFEED METHOD OF FIRING WET WOOD

uniformly constant. The furnace problems, however, are similar to those of the lumber mill and therefore, because fuel is purchased, any improvement in design which provides higher efficiency and close automatic control is of even more interest to them.

Wet-wood refuse from paper-mill operation usually consists of bark, butt ends, culled wood, sawdust, and ground-wood screen tailings. The most important of these, and perhaps the most uncertain as to quantity, is wet bark.

Bark as received from some barking processes contains 80 per cent or more moisture, and in this condition is of no value as fuel. Under these conditions, the bark will not support its own combustion, and it will be necessary to supply heat from some other source if the wet material is to be disposed of in a boiler furnace.

Through the use of mechanical presses, preliminary dewatering must be resorted to if any useful heat is to be realized from the burning of bark. By this means it is possible to reduce economically the moisture content of bark from 80 per cent to 65 per cent thereby making some of its heat content available for steam-generating purposes. Some mills burn the pressed bark together with other wood-room refuse without further preparation. However, hogging the fuel before burning provides a more favorable size consist which in turn makes possible more uniform feeding and also contributes to improvements in the combustion process.

This problem of excessively wet bark is common to all northern mills and the best method of burning, thus far, is the two-stage Dutch-oven furnace. Since power and steam requirements of pulp and paper mills are relatively constant while the wood-fuel supply is variable it becomes necessary to provide a stand-by or supplementary fuel. The units, therefore, depart from the lumber-mill type.

A large Midwestern paper mill has installed several steam-generating units designed to burn wet-wood refuse and pulverized coal. This design, shown in Fig. 2, incorporates a wood-burning furnace consisting of a two-cell Dutch oven with flat grates located below, but opening into a large water-cooled secondary combustion chamber in which pulverized fuel is burned. These units have now been in successful operation for a number of years. The wood fuel is a variable mixture of pressed bark, sawdust, log shavings, knots, culled wood, butt ends, and ground-wood screen tailings, and has an average moisture content of 60 per cent. With this fuel it has been possible to operate at a continuous capacity of 55,000 lb of steam per hr and at peak capacities of 85,000 lb per hr for periods of 15 min. The limitation on output seems to be the ability to supply sufficient wood fuel to the furnace rather than to burn it, inasmuch as the fuel pile on the grates could not be maintained during these high-capacity periods. Supplementary pulverized-fuel firing, either simultaneously with wood or in another unit, is used at times of heavy steam demand or when sufficient wood is not produced.

In many southern mills the sloping-grate furnace has been used for wet bark. A furnace of this type, designed to burn mixtures of wet bark and refuse wood, and arranged for supplementary oil firing, is shown in Fig. 3. The fuel, instead of being fed through a central opening onto a conical pile, enters the front end of the furnace over its full width. Fuel-bed thickness is controlled by a regulating gate. The fuel-supporting surfaces are sloped in accordance with the fuel to be burned and are sectionalized to provide drying and burning

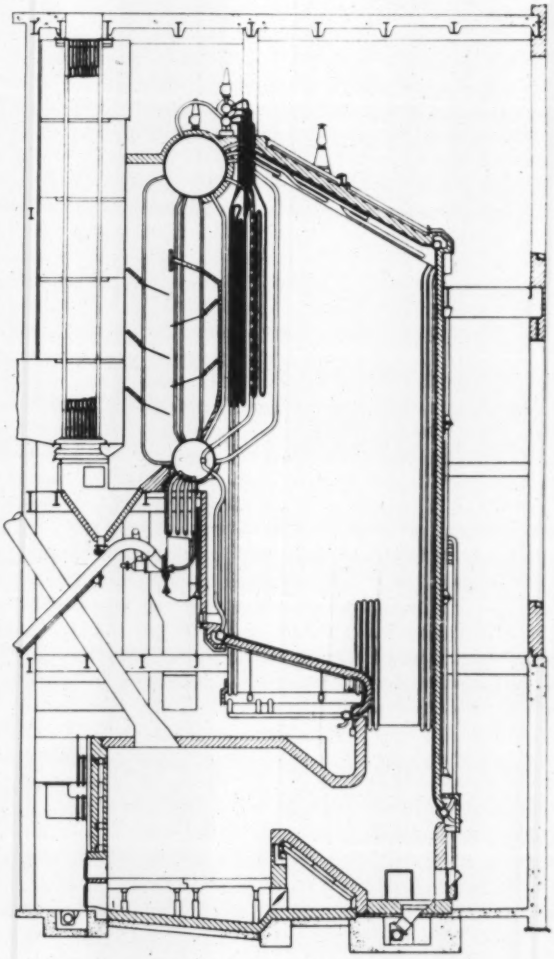

FIG. 2 A STEAM-GENERATING UNIT ARRANGED FOR COMBINATION FIRING OF PULVERIZED COAL AND WET REFUSE FROM A PAPER-MILL WOOD ROOM

(The Dutch oven uses two cells of the single-pile type.)

zones. Air is supplied under grate and through overfire nozzles in the bridge wall. The large secondary combustion chamber, equipped with oil burners, is fully water-cooled.

The two-stage furnace using either flat or sloping grates has burned wet-wood fuel with a fair degree of success in many southern mills. Newer arrangements, however, have been developed to simplify designs and, simultaneously, provide for more effective firing control. In these, spreader-stoker firing made possible through improved sizing of the wood refuse before firing, has been the principal contributing factor. The single-stage water-cooled furnace is used for the wood, as well as supplementary fuels. Air supply and fuel feed may be

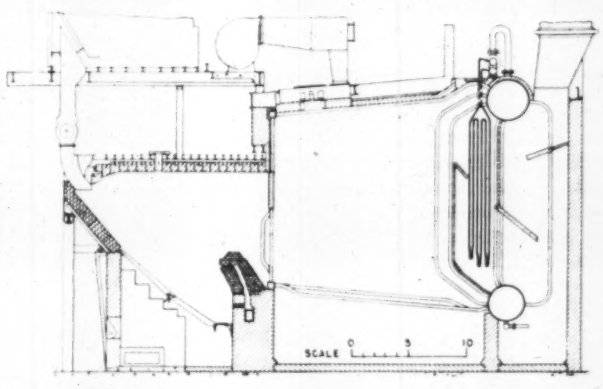

FIG. 3 A PAPER-MILL INSTALLATION IN WHICH THE DUTCH-OVEN FURNACE WITH SLOPING GRATE IS APPLIED TO A BOILER EQUIPPED FOR AUXILIARY OIL FIRING IN THE WATER-COOLED SECONDARY FURNACE

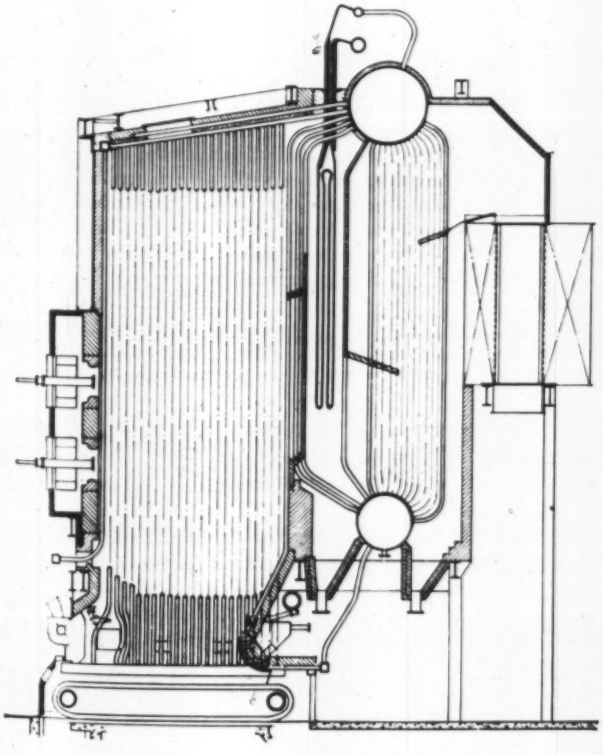

FIG. 4 A SPREADER-STOKER-FIRED STEAM-GENERATING UNIT HAVING A CAPACITY OF 90,000 LB OF STEAM PER HR WITH WET-WOOD FIRING

automatically controlled to maintain consistently uniform operating results. High capacity per foot of furnace width and instant response to changes in steam demand are obtainable without apparent effort. The characteristics of these spreader-stoker-fired units are well illustrated in Fig. 4. Continuous capacity of this unit is 90,000 lb of steam per hr when fired with wood-refuse fuel having a moisture content of 45 per cent. The furnace width is 16 ft $7\frac{1}{4}$ in., and the continuous combustion rate is 155 lb of wet wood or 700,000 Btu per sq ft of grate per hr. The single-stage furnace is fully water-cooled and the spreader unit, while located somewhat higher above the grate than for straight coal firing, is nevertheless well below the point at which the products of combustion enter the boiler bank. This arrangement provides for maximum heat absorption in the furnace and, at the same time, allows ample time for burning of any flying "char" particles thereby reducing stack discharge. Coal may be used in the spreader units as auxiliary fuel. A major portion of the air is supplied under grate, and the remainder enters the furnace through a series of overfire jets in the furnace walls to produce turbulent mixing of the gas as it rises from the fuel bed. In addition to the mixing action the overfire air serves to reduce char carry-over because much of the fuel is dried, ignited, and burned in suspension before it has time to reach the grate. It is this rapid burning action which makes possible the almost instantaneous response of this firing method to changes in steam demand.

Spent-wood refuse from the naval stores plants is a wood fuel whose characteristics differ somewhat from the ones just described. In this process old pine stumps are given a preliminary spraying with water to remove part of the sand and soil carried by their root structure. After this "rinse" they pass through a series of high-speed chippers. The resulting chips and remaining sand then enter the process digester where steam cooking and solvents remove practically all the resin and pitch. The spent-wood chips, devoid of the flashy burning characteristics of pine, are then burned in furnaces to produce steam for process requirements.

The accepted furnace designs for this fuel are of the sloping-grate type having relatively low capacity and requiring considerable manual labor for sand and char removal. The normal continuous capacity for a furnace of this type having a width of 10 ft is from 30,000 to 40,000 lb of steam per hr with CO_2 of 10 to 12 per cent and volumes of black smoke continually rolling from the stack. Response to changes in steam demand is extremely sluggish. Because of these, as well as many other adverse characteristics, a steam-generating unit incorporating a number of new furnace features was given a series of preliminary tests. Performance exceeded predictions in every respect and accumulated operating experience, together with recorded data, provide a basis for many design improvements. An outline of the test unit, which has now been in operation for more than two years, is shown in Fig. 5. It consists essentially of a tall water-cooled single-stage furnace, a two-drum bent-tube boiler, and tubular air heater. A traveling grate is used for supporting the fuel pile and also continuously discharging any sand or ash accumulations into a sluiceway. The spent-wood chips withdrawn from the "live-bottom" fuel bin, by nine large screw conveyers, are discharged into three distributors of the spreader type, located in the furnace wall at a considerable height above the grate level. A series of overfire air nozzles, arranged in four alternate tangential belts, provide highly turbulent zones through which the larger wood chips and much of the sand fall to the grate. The smaller chips are either completely burned in suspension or leave the furnace as char which together with some of the sand accumulate in the boiler hopper or dust collector.

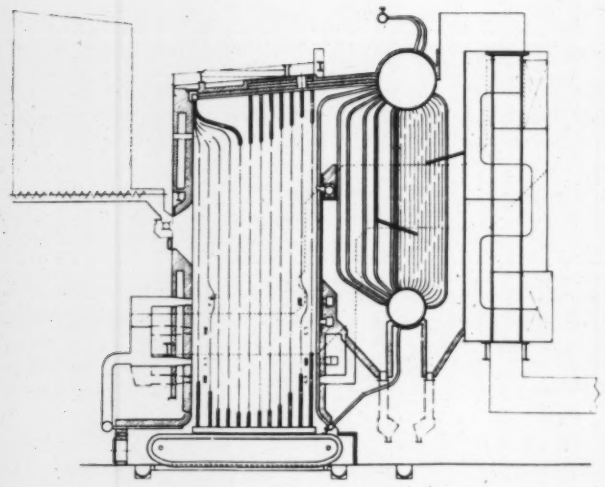

FIG. 5 A LARGE-SCALE EXPERIMENTAL UNIT USING A SINGLE-STAGE FURNACE WITH SPREADER FIRING AND TANGENTIAL ARRANGEMENT OF OVERFIRE-AIR JETS

The air for combustion is obtained from three main sources: (1) Underfire at room temperature, through stoker grate by furnace draft induction, and controlled by doors in each of the stoker compartments; (2) overfire from the air heater, by forced-draft fan to the various furnace nozzles; (3) leakage through distributor units and around stoker seals.

This unit is usually operated continuously at a capacity of from 100,000 to 120,000 lb of steam per hr and a CO_2 of from 16 to 18 per cent with smoke of approximately no. 1 Ringelmann density. This is quite an improvement over the performance of the sloping-grate units having the same furnace width.

During a series of recently conducted tests a capacity of 142,000 lb of steam per hr was maintained for three hours with an average CO_2 of 18.4 per cent when burning spent-wood chips having a moisture content of 37.0 per cent.

Hogged pine bark with moisture content of 44.3 per cent has been used to develop a capacity of 97,200 lb of steam per hr with corresponding CO_2 of 15.5 per cent.

The operating experiences and test results obtained with this experimental unit have provided fundamental data for improved designs in which there would be some rearrangement of overfire nozzles, a revised distribution of the air supplied by the forced-draft fan, modified location of distributor unit, and some rearrangement of furnace dimensions. In this revised unit it would then be possible to burn spent-wood chips, hogged bark (moisture below 60 per cent), hogged wood of all species, and coal or oil. Capacity could be maintained at from 10,000 to 15,000 lb of steam per ft of furnace width and CO_2 of 16 to 17 per cent. The efficiency would depend largely on the size of air heater installed.

This newer type of unit should appeal to plant operators in the northwestern section of the United States not only because of their present wet-wood fuel but also because of the possibility of extracting commercially large quantities of pitch from Ponderosa-pine stumps. This was reported in the Jan. 1, 1949, issue of *Science News Letter* from which the following is quoted in part: "It has been long known that Ponderosa pine stumps contain pitch, but quantity, quality, and costs of extracting were uncertain factors. It is now known that pitch can be extracted commercially. This is a result of work at the Portland, Oreg., laboratory of the Western Pine Association, etc."

With either spreader or underfeed firing it is necessary to have proper sizing of the wood chips to assure uniform feeding and rapid burning. In addition, drying should be carried to as far below the 60 per cent moisture content as is economically allowable. This applies particularly to those operations in which the hog fuel contains a high percentage of bark.

Research investigations are now well under way in a large-scale installation, to develop a newer and more economical means for removing additional moisture from mixtures of hogged pressed bark and wet-wood refuse. Results obtained thus far are encouraging and a full report on this work will be available in the near future.

Preserving Liberty

(*Continued from page 734*)

direct incidental man-to-man contacts but also such media as house organs, foremen's meetings, and occasional meetings and gatherings of various kinds, the "bargaining table," and even Annual Reports. And, finally, I would like to express a hopeful note. The over-all situation is undoubtedly grave. While possibly the clock has not actually been turned back, there are indications that it is losing time. However, it is still ticking strongly and will, I think, make up for lost time if we make an honest, concerted effort to return to the principles which made this nation great. My net impression is that the great majority of the men and women of the United States of America still value their liberties and are not only willing, but anxious, to work with enthusiasm and even to sacrifice for others. The spirit of the men who have suffered for freedom in this country still informs us.

We are being bombarded with glittering persuasion that if we will give up our individual liberties to a benevolent, paternalistic system, all problems will be solved for us and life will flow on for all like a sweet dream, without struggle and practically without work. However, most of the men and women of America still do not quite believe it. They still have an uneasy feeling that it is all too cheap and also—and this is significant—that they never can get something for nothing, and they would not like it if they could. I still think, therefore, that communication based upon a creed which springs from the foundations laid here nearly 200 years ago (dented and worn a bit in the meantime, perhaps, but still sound) will be effective.

THE CREED OF FREEDOM

I would express that creed—inadequately I am afraid—as follows:

1 The acceptance of competition as a wholesome and proper principle by which to live.

2 The need (the "right" if you will) of recognition of achievement.

3 The voluntary acceptance of differing (functional) responsibilities, all integrated to a common purpose.

4 The assumption of responsibility, in the discharge of these functions, to the others engaged in the common effort.

5 The obligation to recognize the dignity of each as an individual.

6 The acceptance of the principle of graduated criteria of performance, that is, much should be demanded from him to whom much responsibility is given.

7 And, finally, the realization that effective compulsion for the discharge of responsibilities can come only from within the heart of each individual.

How Can the Effectiveness of ENGINEERING EDUCATION BE IMPROVED?[1]

By H. P. HAMMOND

DEAN, SCHOOL OF ENGINEERING, THE PENNSYLVANIA STATE COLLEGE. MEMBER ASME

WHAT follows are the notes used in discussion of the topic of increasing the effectiveness of engineering education at the Education Conference of the Society on March 21, 1949. These notes have been edited or amplified but slightly, and therefore seem somewhat abrupt and dogmatic. However, since they embody convictions based upon long experience and study, they are presented in their original condensed form. If the notes prompt further discussion, they will have served their original as well as their present purpose.

WAYS TO IMPROVE EFFECTIVENESS OF ENGINEERING EDUCATION

Exclusion of Poorly Qualified Students From Admission. While engineering students as a group are above the average in ability of other groups, far too many are admitted to engineering colleges who do not possess the ability needed for a professional career. Admission of these poorly qualified students not only leads to excessive scholastic mortality, but also congests classes and leads to confusion of aims of the engineering educational processes. Furthermore, too many of these students are continued to graduation. I would not say that all the fault lies with the students in these cases; the colleges also must share the responsibility for excessive failures. But the fundamental fault rests upon our admissions system which does not discriminate properly among candidates for admission.

Engineering Curricula. Engineering curricula should be simplified, reduced in total requirements, and devoted more to fundamentals and less to applications. Students should not spend less time on their work, but should concentrate on smaller coverage of ground with consequent improvement in mastery of fundamental principles.

A good deal of lip service is given to "teaching of fundamentals," but, as a matter of fact, this is not carried out in practice. Curricula are not only overburdened with courses of study but the individual courses cover so much ground that even the best student cannot master them.

In my opinion, decrease of from 15 to 20 per cent in ground to be covered with corresponding increase in thoroughness would raise the general effectiveness of engineering education to a very great degree.

Underlying Principles of Engineering. Principles underlying broad sections of engineering are comparatively few in number and can be expressed in simple form. As presented in textbooks and taught in the classroom, however, these principles are usually expressed in relatively complex derived forms as applied to a particular problem or subdivision of subject matter. Teachers often fail to show how these derived equations have been developed from the basic law. Hence the student, by learning in ad hoc fashion, does not gain mastery of the fundamental principle or the ability to apply it to unfamiliar situations. Therefore he lacks resourcefulness when confronted with the new situation of professional practice. This is one of the most serious weaknesses of engineering education.

Clearing out excess baggage of poorly qualified applicants, reducing purely informational subject matter, and teaching primarily from the simple fundamental statements of basic laws would do much to increase the effectiveness of engineering education.

The Lecture. The practice, which is all too prevalent, of having the teacher "recite the lesson for the student in the classroom" should be substantially eliminated as a form of instruction. The lecture has a place in engineering, as in other types of education, but it should not be the prevailing form of class exercise, as it now is. This is a way of saying that the most important factor in good teaching is to have the student do the work instead of having it done for him by the teacher. Very little is learned thoroughly which the individual does not do or experience for himself. At present, failure to do this is a very serious fault in engineering education. It is due in part to the overcrowding of curricula, and in part to the harder work that a genuine "drawing out" educational process requires.

Original Work. Somewhere, somehow, in the undergraduate years, the student should be given the opportunity to do a little original work on his own initiative, under guidance of the teacher of course but not under the close direction which prevails up to the very end of the curriculum. A great fault of engineering education is to dampen the spirit of enterprise and the desire to create with which most students enter college. Instead of tending to stifle originality in our students, the reverse should be the case; we should plan to encourage it. The effects of the introduction of an opportunity for original work on the part of students is a revealing experience.

Recitation, Laboratory, and Design. Too often the three instructional processes—recitation, laboratory, and design—which afford an unmatched opportunity for the close integration of methods, with consequent growth in student knowledge and capacity to do, are not capitalized properly. Too often the laboratory work is largely dissociated from work in the classroom. This is a fault which should be readily remediable.

Social Studies and Economics. The proportionate time allotment for the so-called humanistic-social courses of the curriculum has been the subject of a great deal of discussion in recent years. I am in favor of the 20 per cent allotment advocated in the ASEE reports of 1940 and 1944. The planning of the curriculum with this in view, while not always easy in view of faculty attitudes, is the easiest part of the problem of giving engineering students an introduction to a conception of their obligations as citizens, some knowledge of the social and

[1] A summary of discussion on this topic at the Annual Education Conference of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, New York, N. Y., March 21, 1949.

economic implications of engineering, and an appreciation of the broader cultural interests of engineers. Allotment of time in the curriculum is only the start of the process that is needed properly to plan the courses, select the subject matter, and secure the kind of instruction which will meet the needs of engineers.

It is often more difficult to do this in a university than in an institute of technology. In the former, where the liberal-arts faculty often has little appreciation of the attitudes and interests of engineers, the results of replacing sound technical courses with an equal allotment of humanities is likely to be very disappointing. For one thing, these courses are often found not to be truly "cultural" for engineers. Rather, they are often narrowly technical. Some courses, such as in psychology, which should be valuable for engineers, are narrowly specific and planned as a first course in a technical sequence for "psychology majors." Courses in economics, which should be of great importance in the education of an engineer, are often worthless to the majority of our students and are likely to do more harm than good in driving them away from further interest in the subject.

The devising of a sequence of general studies of nontechnical nature in engineering education is in most instances a difficult problem to which much skill, insight, and diplomacy must be brought to bear. The mere listing in the catalogue of a group of liberal-arts courses is not even the approach to its solution. What is needed, in the interests of better-rounded engineering education, is, first, the selection of the fields of study that are of most direct and vital interest to the education of a professional engineer—economics, psychology, sociology, introduction to literature; then the systematic planning of individual courses of study, and the selection of subject matter of those courses; and, finally, the devising of methods of instruction suitable for engineers. This is often a slow and troublesome process, but it is essential. Until the engineering faculty can be assured that the desired end can be achieved, I believe they should not replace sound scientific and technical courses by humanistic-social courses of doubtful value. That the desired end can be accomplished is being demonstrated in several institutions. When it is accomplished, the result is a better-rounded program for the preparation of a profess onal engineer.

The Engineer's Part in Modern Society. The development among engineering students of knowledge and appreciation of the part that the work of engineers plays in modern society cannot, and should not, be left entirely to the teachers of nontechnical courses. The engineering teachers themselves have a definite responsibility in this connection and there are great opportunities for them to discharge this responsibility. As an example, we all know the profound effect that the development of the steam engine and boiler about one hundred fifty years ago had in replacing muscular power by mechanical power in doing the world's work. This event was, in fact, one of the great turning points in the history of the world. Yet I doubt whether there are very many teachers of heat power who take the time to refer to this aspect of the course they are teaching or to capitalize on the opportunity that presents itself to broaden the horizons of their students and, by inference, to lead them to understand how their own work of the future will affect the people of the world. It would not take very long in a class briefly to summarize the story of the evolution of heat power and to speak of Newcomen, Watt, Parsons, Curtis, Otto, and others. If this is well done it can illuminate the entire course and orient it to our social background. The same thing is true and the same opportunities exist in courses in electrical circuits and machines, electrical communications, and so on.

Coupled with sound courses of the humanistic-social stem of the curriculum, instruction of the type here mentioned can do a great deal to aid in producing a truly well-educated engineer.

Five-Year Courses and Graduate Study. If undergraduate curricula are to be lightened in total content and broadened in scope, it follows that they must be lengthened in duration for students preparing for the higher levels of practice. This means either the five-year undergraduate program or, preferably, as I believe, postgraduate work of a year or more for properly qualified students. A good start has been made in that direction, but more progress is needed, and the postgraduate programs and teachers of many schools need greatly to be strengthened if it is to be accomplished satisfactorily.

History and Development of the Grand Coulee Pumping Plant

(*Continued from page 732*)

FIELD TESTS

After installation in the field, the pumps will be tested to determine the operating characteristics over a range of heads. The accurate measurement of the large rates of flow involved is a problem of considerable magnitude, and extensive investigations have been made on this subject. Present studies point to the adoption of the salt-velocity method of water measurement and improved apparatus for the rapid injection and uniform distribution of the brine solution has been developed. The head would be controlled by means of a series of orifices inserted into the discharge pipe.

CONCLUSION

In this paper the salient features of the Grand Coulee Pumping Plant have been described with special emphasis placed on the mechanical and hydraulic problems involved. In other papers presented at the 1949 ASME Semi-Annual Meeting the hydraulic model tests on the pump and the construction of the prototype pumps are described in more detail.

ACKNOWLEDGMENTS

The hydraulic studies described in the paper were performed under the direction of I. A. Winter, Head of Hydraulic Machinery Division. All engineering designs for the pumping plant are under the direction of L. N. McClellan, chief engineer, director, Branch of Design and Construction, Bureau of Reclamation, Denver, Colo. All activities of the Bureau are under the general charge of Michael W. Straus, Commissioner, Washington, D. C.

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POPULATION PROBLEMS[1]

By RALPH E. FREEMAN

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MALTHUS in his essay on population published in 1798 concerned himself with the relation of population growth to human welfare. Since he believed that people had a tendency to multiply faster than the food supply, he held out little hope for permanent improvement in human living conditions. Subsequent developments, however, seem to have proved that Malthus was wrong, for throughout the nineteenth century population increased while standards of living rose. Interest in population problems died down.

In recent years this interest has revived. In India, China, and other parts of the East, the views of Malthus are commanding increased attention because they describe quite accurately the situation which now exists in many of those countries. In the West there is also a revival of interest in population problems—not because of the pressure of population upon subsistence, but because there is danger that the number of people will soon cease to grow or even decline.

This contrast between the East and the West is of far-reaching significance. The future expansion of world population in the foreseeable future will be chiefly in eastern and southern Europe, in Asia, and other so-called backward areas. These regions are almost certain to adopt the industrialism of the West—and Mr. Truman's "bold new program" is destined to speed up the process of industrialization. What may then happen to the balance of economic and political power in the world is suggested by the recent history of Japan.

Warren S. Thompson in his book[2] "Plenty of People," discusses the implications of this differential population growth between East and West. He also makes some interesting suggestions as to how economic and political friction resulting from this development may be avoided. He sees a need for more effective use of the tropics where there is much undeveloped land, also for a freer trade throughout the world, and for a political organization to insure that all peoples have fair access to the world's resources.

Mr. Thompson prefaces his discussion of this question with a survey of the population growth since 1800, giving considerable attention to birth rates and death rates in the principal countries of the world. He also analyzes the various factors controlling the birth rate. "People who live under rural conditions have larger families than those who live in cities. Women who work outside the home have smaller families than those who do not. People in good economic position have smaller families than those who are not so well off." American readers of this book, however, will probably be most interested in his discussion of the population problem of the United States.

The growth in the population of the United States has slowed down in recent years primarily because of a decline in the birth rate. Mr. Thompson states that—assuming that the birth rate continues to drop, but at a slower pace than formerly, and that the decline in the death rate will also become slower—the United States will probably attain a population of about 165 million by 1975. Thereafter, save for a short period of relative stability, our numbers will begin to diminish.

The author believes that 165 million people is a reasonable aim for the United States. He believes that considering the resources at our disposal and the standard of living which most Americans desire to achieve, this size of population will probably be in the best long-run interest of the people. Our policy, therefore, should be to maintain our population at approximately this level. We should take measures, consistent with the preservation of democracy, to prevent the decline which is likely to occur after 1975, should the present trend in the birth rate continue.

Assisting parents with the expenses of raising children is an essential part of such a population policy. This assistance may be given in various ways—low-cost housing, better and cheaper health service for children, and more scholarships for children of parents with low incomes. The extension of our social-security system would remove an important handicap to larger families. Many people now refuse to assume the obligations of parenthood because of the feeling of insecurity connected with unemployment and old age.

The author points out, however, that economic factors are not the most formidable barriers standing in the way of maintaining the birth rate. This view is substantiated by the fact that as a general rule families in the higher-income group have fewer children than those in the lower-income brackets. He emphasizes, therefore, the importance of the psychological element. What is needed is a change in the climate of opinion as it affects reproduction. If society comes to place a higher value and esteem on having larger families, people will conform to this pattern. "We shall have to substitute the ideals and satisfactions of family life for the satisfaction of ever-higher levels of competitive consumption and the attainment of other forms of personal prestige, before we can hope to keep the birth rate at maintenance level."

The author does not tell us how a new climate of opinion can be created. He admits that he does not know the answer to this and various other questions raised in the course of the discussion. In fact, the chief value of the book lies in the problems raised and the facts presented that throw light on the nature of the problems, rather than in any suggested solutions.

"Plenty of People" is for the general reader. It avoids technical discussion and passes over many points which would be of interest to specialists. Perhaps the most serious omission is the inadequate treatment of resources as a factor in the population problem. What science may be able to accomplish to expand the future output of food and other necessities of life is virtually ignored. No doubt Mr. Thompson felt that to deal with this vast subject would require too much additional space.

There is no doubt that the future of this country depends in large measure on world population changes. Consider, for example, our relations with Soviet Russia. The percentage increase in the number of people in Russia during the period 1940–1970 is likely to be more than double that of the United States. And this growth of population will be accompanied by increased application of the machine technology of the West. The reader will find in Mr. Thompson's book an excellent introduction to this and other population developments vitally affecting the welfare of the American people.

[1] One of a series of reviews of current economic literature affecting engineering, prepared by members of the Department of Economics and Social Science, Massachusetts Institute of Technology, at the request of the Management Division of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Opinions expressed are those of the reviewer.

[2] "Plenty of People," by Warren S. Thompson. (Scripps Foundation for Research in Population Problems), revised edition, 1948, Ronald Press, New York, N. Y., 270 pp.

BRIEFING THE RECORD

Abstracts and Comments Based on Current Periodicals and Events

COMPILED AND EDITED BY J. J. JAKLITSCH, JR.

MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context and credit to original sources is given.

Nuclear Education

ENGINEERING schools of the nation should revise their courses of study so that engineers and scientists will be adequately trained for the development of atomic energy, writes Major General Kenneth D. Nichols, chief of the Armed Forces Special Weapons Project, National Military Establishment, Washington, D. C., in the July issue of *Nucleonics*. He points out that the time has come when engineering schools should make certain revisions and additions to their curriculums which would better qualify graduate engineers for handling nuclear engineering problems. He stresses this point by saying that there is no mystery about atomic energy that good engineering cannot solve.

General Nichols does not think that just one course in the engineering school is the answer. The introduction of nuclear-engineering courses in civil, mechanical, electrical, and chemical engineering is necessary. He notes that most universities have already tackled the problem of training graduates for atomic-energy development, but too many have stressed the research approach rather than the engineering approach, which he maintains is of major importance. At the present time, many engineers have the experience derived during the war, but most engineers lack additional educational training that permits them to solve these new problems without learning new principles required by the atomic era.

Chemical engineering involved in the production of power or in the production of plutonium is the major problem that must be more efficiently solved if we are ever to have competitive atomic power.

Greater progress can be made if engineers are trained to handle nuclear problems just as chemical engineers are trained to handle chemical problems involved in the engineering, design, construction, and operation of production plants. Instead of giving a few courses in engineering to a student who is essentially a physicist, a chemist, or a metallurgist, greater emphasis should be placed upon giving students who have a basic engineering education, the principles of physics and the problems of nuclear engineering involved in the particular field of engineering.

General Nichols notes that in attempting to develop proper educational courses, secrecy and government control of the atomic-energy field may appear to be limiting factors. However, there is much information available upon which an effective start in the field of education can be based.

The article concludes with the recommendation that university engineering departments seek contracts from the AEC or with its contractors for the development of the engineering research in this field. Also, more professors should seek temporary employment with the AEC and its contractors so that they can get firsthand information about the problems involved. They will then be in a better position to determine the basic educational courses in the field of physics and physical chemistry required and the revisions and additions necessary to our more standard engineering courses.

Wind Power

A REALISTIC view of the ways and means by which bulk electric power may be obtained from the wind was given by Percy H. Thomas, Mem. ASME, Federal Power Commission, Washington, D. C., in a paper which he presented before the United Nations Scientific Conference on the Conservation and Utilization of Resources (UNSCCUR) at Lake Success, L. I., N. Y.

Some ten years ago Palmer Cosslett Putnam of Boston, Mass., was able to interest several of the best known of our large engineering concerns, under the sponsorship of the S. Morgan Smith Company, to build a wind turbine of 1000–1250 kw capacity on a small mountain in Vermont, called Grandpa's Knob. The services of well-known experts in several related lines were obtained, aerodynamic, meteorological, structural, etc., and the installation was completed in 1941. This was known as the Smith-Putnam turbine and was connected to an operating utility as a source of auxiliary power. It is reported to have been able easily to supply 1000 kw to the utility system at the rated wind velocity of 30 mph, and to generate even up to 1400 kw in favorable winds. (See MECHANICAL ENGINEERING, June, 1941, page 473.)

However, this unit was unfortunate, and had a checkered career. Completed during the war, certain necessary repair

How to Obtain Further Information on "Briefing the Record" Items

MATERIAL for this section is abstracted from: (1) technical magazines; (2) news stories and releases of manufacturers, Government agencies, and other institutions; and (3) ASME technical papers not preprinted for meetings. Abstracts of ASME preprints will be found in the "ASME Technical Digest" section.

For the texts from which the abstracts of the "Briefing the Record" section are prepared, the reader is referred to the original sources, i.e.: (1) The technical magazine mentioned in the abstract, which is on file in the Engineering Societies Library, 29 West 39th St., New York 18, N. Y., and other libraries. (2) The manufacturer, Government agency, or other institution referred to in the abstract. (3) The Engineering Societies Library for ASME papers not preprinted for meetings. Only the original manuscripts of these papers are available. Photostat copies may be purchased from the Library at usual rates, 40 cents per page.

parts could be obtained only after extraordinarily long delay, and finally certain fatigue cracks developed in the blade shell and in the internal framing, as reported, leading to structural failure. This unit was then abandoned, apparently as the feasibility of the operation had been established, and redesign of the structure to eliminate the defective parts of the original unit would have been unreasonably expensive.

Mr. Putnam reports that this unit was turned over to the utility staff for regular operation early in March, 1945, and that it ran continuously on load, night and day, whenever the velocity of the wind permitted, for three weeks, and that it ran uneventfully until the occurrence of this fatigue failure, under a light load, closed its career.

The fact that a wind turbine could be designed and built to deliver successfully 1000 kw and operate continuously for hundreds of hours in routine service seems to establish at least the feasibility of wind power for utility supply, Mr. Thomas pointed out.

Mr. Thomas revealed that two distinct designs have so far been proposed: (1) The Smith-Putnam turbine offers one model; a single 30-ton, 175-ft wheel with two blades, mounted on a slightly inclined shaft on the top of a 125-ft tower, and adapted to be revolved automatically to face the wind. On the same revolving platform with the wheel are the generator and all auxiliaries. Gears are required to speed up the slow wheel rotation to a proper speed for the generator which runs in synchronism with the utility. The blades feather to the wind, under governor control, to vary the load. (2) After studying this Smith-Putnam turbine and its performance, Mr. Thomas undertook to make a study-design for an aerogenerator of much larger capacity (7500 kw) and one that would avoid some of the difficulties shown by the experience of Grandpa's Knob. In this latter design, to tap as large a body of wind as possible, two wheels are provided, each 200 ft in diam, located on the two ends of a 235-ft bridge, revolving on a turntable located on the top of a 475-ft tower. These wheels have three blades each, fixed in position in the hub, but without the feathering feature. On account of the terrific aerodynamic thrust upon these blades, due to their high speed, 550 fps at the tip, a tension brace leading from the hub is provided for each blade to give it sufficient strength.

This high tower is desirable for two principal reasons: First, the wheel of a high-speed impact-type turbine like this, draws upon a cylinder of the wind several times as great in diameter as the wheel itself, and so should be given a sufficient clearance from the ground for this air cylinder. Second, the velocity of the wind and its smooth streamline character are definitely more favorable several hundred feet above the surface. As a sufficiently high average wind velocity is very important for economy in the wind turbine, the more favorable velocity high above the ground assumes an almost dominating importance. This will be realized when it is remembered that, while over level ground, the wind velocity may increase some 40 per cent in the first 500-ft rise in elevation, the energy content of the wind would then increase as the cube of this velocity, that is, by 275 per cent. It is surprising to note that according to estimates, the cost of this 500-ft tower is less than 25 per cent of the whole aerogenerator cost.

In this study-design, the two wind wheels are connected to a single shaft through step-up gears and jointly drive a direct-current generator. This generator thus runs synchronously with the turbine which operates at a speed proportional to the wind velocity. The direct-current energy is transformed to alternating in an inverted rotary converter, which runs in synchronism with the delivery power circuit. This flexible arrangement permits a most favorable extraction of the wind energy and offers an opportunity for a simple automatic control of the wind speed. It has the obvious advantage of a double conversion of energy and the addition of the cost of the inverted rotary.

Some assistance in the search for wind-turbine sites may be obtained by studying the physiographic characteristics of the area selected, which should be one in which there is an observed tendency to windiness. It is helpful to imagine the wind as a vast stream of water flowing over the surface of the country like a river. Looking at a brook or rapid river, the "fast water" is seen to run between stones and over obstructions on the bottom, and where the slope is the steepest. It is the same way with the wind. It may be assumed that several of the following tendencies may be acting simultaneously:

1 The highest average wind will occur when there is the least surface obstruction, considered over a wide area, as the ocean or a large lake.

2 Velocity of wind will tend to be high on down slopes due to gravity, as with water.

3 Where there are many houses, trees, and unevenness in the ground surface, the wind will tend to be slowed down, this effect extending to elevations above the ground many times the height of the obstruction.

4 A single isolated obstruction tends to cause an increase in the velocity of the air locally without greatly affecting the over-all stream velocity. Such isolated obstructions are favorable to fringes of high wind velocities. If the obstruction is narrow and high, the wind will go around both sides of it. If it is long and low, like a rolling hill, the wind will speed up over the top.

5 Streamline flow, as distinguished from turbulence, is very important, and difficult to find in the wind near the ground.

6 Because of the resistance at the surface of the ground, the velocity of the wind is greater at higher and higher levels, more or less in what is known as a "logarithm" ratio. In open, flat country, balloon measurements in the United States have shown an average increase in velocity of some 40 per cent at about 500 ft above the ground, with further increase still higher.

ASME and Safety

A PAPER "ASME and the President's Highway Safety Conference," was presented by J. J. Bailey, at the 1949 ASME Spring Meeting in New London, Conn., in which he outlined the history of the National Committee for Traffic Safety, of which ASME is a member, and explained the Committee's purpose in the President's Highway Safety Conference.

Mr. Bailey stated that the original seed for a national program was planted in 1943 at the National Safety Congress in Chicago, Ill. It was primarily a movement to anticipate the dangers of postwar driving when restrictions on gasoline and car usage were lifted and new cars were available.

Forty different groups were represented, including technical societies, professional organizations, service clubs, civic organizations, and others, but all these were working on local levels. This group realized its limitations but agreed that the principles were sound. It voluntarily made the suggestion that it be superseded by a new group which would be truly representative of all organizations and be operated on a national level. In 1945 the committee was continued, and the leaders constantly sought to avoid the pitfall of being known as a "Super Safety Agency," by duplicating or overlapping the work being done by constituted organizations. Now 47 national organizations were represented and the need for a full-time staff and secretary was established. The vast civic groups were ready and willing to support this humanitarian program.

They also realized that the headway already made and the need would carry them far beyond the so-called "postwar period." After a poll of members, the committee was permanently named the National Committee for Traffic Safety. The prime purpose was to represent organizations and not individuals. There existed no set of confining by-laws. The only requirement was "a substantial interest in traffic safety and in developing public interest for highway safety among its members or the general public."

In 1946 the President of the United States called a Highway Safety Conference in Washington, D. C., because of the terrifying toll of highway accidents. As this conference progressed the position of the National Committee was quickly recognized. Here was a Committee already established and representing 77 national organizations of over 128,000 local units.

It would be the most logical agency to expand further and also act as a clearing house. Therefore, in May, 1946, this Committee accepted the responsibility. ASME has been active and well represented at all meetings. E. R. Granniss, Mem. ASME, has attended meetings either personally or instructed a representative to attend and report. The meetings were held either in Chicago or in Washington. In addition, regional meetings were also conducted to tie in the activities from the regional to the national level. ASME attended these meetings and offered helpful suggestions to cope with the problems of highway accidents. ASME has always been interested in the safety of mankind. Members for years have been working on the various ASA codes to develop engineering standards that will protect human life, limb, and property. As individuals, they have been attending various meetings held locally on traffic safety. Throughout industry, they are members of committees working out the problems of safety and accident prevention. Most of this work has been going on unnoticed and unrecorded, Mr. Bailey said.

Reports are being published by the National Committee for Traffic Safety, at various intervals. It is felt that the activities of ASME in traffic-accident prevention should be part of that report.

It is agreed that the facilities of ASME are not as readily adapted to a large promotional program as the other organizations represented in this Committee; however, the following program is proposed to represent ASME as a group supporting the Committee on highway safety: (1) Send to each member a letter on the subject. Describe the work briefly and indicate the approval of ASME; (2) Send to members the monthly pamphlet or leaflet issued by the Committee that covers the subject of safety for that month; (3) Supply all members with a list of the other supporting groups. Members may find that they are also members of a local group supporting the program; (4) Urge isolated members to interest themselves in the local activities as members of ASME; (5) Write articles for MECHANICAL ENGINEERING or *Traffic Safety*. Also, intersperse through each issue safety slogans in boxes; (6) Request members to write to ASME of their personal activities and problems in this work.

Aluminum Braces

ALUMINUM orthopedic braces with mass-produced interchangeable parts are now being manufactured as a result of the co-operative efforts of the Army, the Veterans Administration, the Lofstrand Company, Aluminum Company of America, and other technical personnel, the *Aluminum Bulletin* for June, 1949, states. From stock parts, it is expected that trained fitters will be able quickly to assemble a custom-made brace to meet the needs of individual patients.

Arising from the need for a light, well-fitting, easily fabricated, and durable brace to facilitate the problems of rehabilitating the war wounded, the brace research program was initially conceived by the Research and Development Board, Office of the Surgeon General, in the fall of 1945. Aluminum alloys were chosen for this application after consideration had been given to plastics and other lightweight materials.

Aluminum forgings, tubing, and screw-machine parts for the braces are supplied by Alcoa, and the Lofstrand Company of Rockville, Md., manufactures the finished brace parts. Sitrrup forgings are made from alloy 14S and shipped to the Lofstrand Company with the T4 temper. Lofstrand then machines these forgings, anneals and hot-bends them to the desired shape, and performs the final heat-treatment. The remainder of the forgings are made from alloy 75S-T6. Screw-machine parts are also made from alloy 75S, and the rectangular tubing from alloy 24S.

The new braces have many advantages. A physiological fit is made possible by the use of multipivot knee joints. Because of the aluminum construction, the new braces weigh only about one half as much as old-type braces. Despite their lightweight, however, the braces are made rigid by the use of rectangular aluminum tubing for the side bars. All exterior and working surfaces are "alumilited," which increases the corrosion resistance of the metal and assures smooth-working, long-lasting joints. As the parts of the braces are mass-produced and interchangeable, individual parts can be replaced without buying a whole new brace.

It has been estimated that there are 12,000,000 orthopedic patients in this country of whom 2,000,000 wear full braces. The Lofstrand Company expects to make the braces available to the country as a whole after commitments to the Army have been fulfilled.

Turbulent-Velocity Measurements

AN experiment for determining the root-mean-square turbulent-velocity components parallel to and perpendicular to the mean flow of a liquid in a pipe as a function of radial position and flow rate, was described by L. M. Grossman and E. A. Shay, of the University of California, Berkeley, Calif., at the 1948 ASME Annual Meeting.

The physical principle upon which the experimental method is based is Faraday's law of electromagnetic induction which indicates that electromotive forces are induced in a liquid conductor moving relative to a magnetic field, the electric field strength at any point being equal to the vector product of the magnetic field strength and the velocity. Measurement of the magnetic field and the induced emf enables one to compute the velocity at any point in a flow field.

Water containing a small concentration of salt is pumped through a steady-flow constant-head system consisting of a long length of smooth electrically nonconducting 2-in. pipe at velocities from 2 to 8 fps corresponding to a range of Reynolds numbers from 20,000 to 100,000. At the measuring station approximately 150 diameters downstream from entrance the liquid flows transversely across a steady magnetic field of 2600 gausses. An electrical probe consisting of two closely spaced fine wires is arranged to traverse the pipe cross section in the vertical plane to measure the distribution of the fluctuating potential gradient. The electrical impulses picked up by the probe are amplified and their root-mean-square values measured by means of a thermal milliammeter.

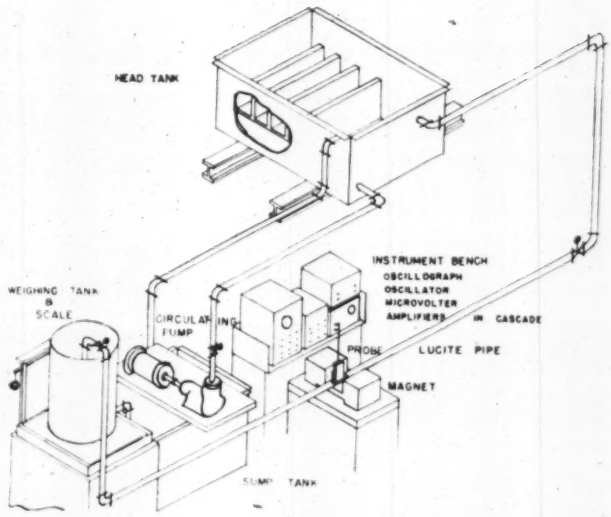

FIG. 1 ISOMETRIC SKETCH SHOWING THE ARRANGEMENT OF EQUIPMENT USED IN THE INVESTIGATION OF NONISOTROPIC TURBULENCE IN LIQUID PIPE FLOW

General agreement with previous nonisotropic turbulence measurements and good reproducibility of experimental values substantiates the applicability of the induction method in microturbulence research. Further experimental data as well as refined calibration techniques should yield information on the reliability of the absolute magnitudes of turbulence intensities measured by this method.

The method is said to offer attractive possibilities in the experimental study of the details of the velocity fluctuations in the turbulent flow of a liquid. The difficult problems of thermal lag and the necessary compensation circuits familiar in the technique of hot-wire anemometry are eliminated in the electromagnetic induction method. Moreover, the hot-wire anemometer—the primary device developed to date, of a sensitivity and reproducibility sufficient to measure the details of turbulent fluctuations required in the experimental verification of modern statistical theories of turbulence—is by its inherent limitations restricted to gas flows. The only available experimental information on microturbulence in liquids is based upon optical methods of flow visualization.

In contrast to the foregoing advantages, in actual application to the study of liquid turbulence the electromagnetic method involves the measurement of small (in the present experiment of the order of 10^{-5} volts) transient potentials which may be masked by the effect of spurious potentials of a much greater magnitude unless fairly elaborate experimental precautions are taken.

Another inherent difficulty of the method is that the distribution of potential gradient due solely to the induction effect will be disturbed by the presence of current flow within the fluid field, at the flow boundaries or through the measuring circuit. The two latter effects may be eliminated by the use of electrically nonconducting pipe walls and high-impedance detectors, but there still remains the possibility of "short-circuiting" currents between points in the fluid where the velocity gradients are large. These induced currents may also have the secondary effect of modifying the original flow due to the ampere forces between the magnetic field and the currents giving rise to an additional resistance to the flow of the liquid. In the case of an aqueous solution of high resistivity, however, where the velocity distribution is essentially flat as in the present experiment, it can be shown that the effect of current flux in modifying the distribution of potential gradient or the velocity field is of a negligible order of magnitude.

Sonic Research

DURING the fiscal year which began on July 1, six branches of the U. S. Government received about $454,805,000 for aeronautical research, some $32,000,000 less than was expended in fiscal 1949, the CADO *Technical Data Digest*, June 15, 1949, reports. The National Advisory Committee for Aeronautics (NACA), one of the six agencies involved, has allocated 35 per cent of its $48,700,000 budget to transonic aerodynamics.

The others, including the Air Force, the Navy Bureau of Aeronautics, the Army Ordnance Department, the Navy Bureau of Ordnance, and the Civil Aeronautics Administration are all interested in the same problem and they too are spending large amounts to find out exactly what happens when an airplane flies just at, near, or above Mach 1.0.

These experiments have been going on since 1944, when the Government undertook a program of piloted high-speed flight research.

By combining wartime NACA research with captured German data made available through what is now the Central Air Documents Office, interested agencies concluded that there were four possible ways of solving the problem of high-speed flight. The possible solutions were: (1) thin wings, (2) sweptback wings, (3) low-aspect-ratio wings, and (4) high-speed wing profiles. A fifth device, the tailless aircraft, was added later.

Naval aviation was assigned to monitor low aspect ratio and wing sweep, and U.S.A.F. wing sweep and thin wings, and the NACA special wing profile.

Aircraft were designed by various industry design teams on the basis of NACA research data and sponsored by conventional Navy and Air Force procurement contracts. The project, which is jointly administered by the U.S.A.F., the Navy, and the NACA, was set up at Muroc Air Force Base, Calif., which has a seven-mile-long runway.

Already built and flying are four craft, two built for the Air Force and two for the Navy. The Bell X-1 was the first to fly and crack the sonic barrier, doing so on October 14, 1947. It uses an extremely thin-wing profile and is powered by a Reaction Motors rocket engine.

Several weeks earlier, the Navy's Douglas D-558-1, a turbojet-powered craft with short broad wings (low aspect ratio), shattered the world speed mark by flying 650 mph, but this record was in turn surpassed by the U.S.A.F.'s conventional F-86 a year later.

Third research plane to take to the air was the Douglas D-558-2 Skyrocket, which combines low aspect ratio with sweptback wings. The Skyrocket is powered by a Westinghouse J-34 turbojet and a Reaction Motors rocket engine and recently made its first flight using both.

The X-4, built by Northrop, is a tailless, swept-wing, twin-jet research ship designed to fly just below and at Mach 1.0. It will therefore provide not only general information about flight in the transonic region but also data on the tailless sweepback design.

Still to be delivered to the Air Force are three other research models, including the Bell X-2, a swept-wing, stainless-steel rocket-powered craft which will be even faster than the X-1 which, according to official announcements, has flown "several hundred miles an hour faster than the speed of sound."

Despite the fact that scientists pretty well know the special configurations needed to produce lift and reduce drag, they still need the data to refine these configurations and thus make the

finished aircraft (or missile) highly efficient. These scientists, for example, are aware of means of minimizing stability and control difficulties at transonic speeds, but they still have a great deal to discover about the modifications needed for efficient operation at maximum speeds and while landing.

Advanced mathematical methods developed within the last year, and special calculators have made possible considerable progress in stability and control theory, but here again much of the design data must be reconciled with the full-scale plane. Internal aerodynamics problems are still complicated by boundary-layer analysis. Nose inlets have been mastered but wing inlets, especially in the root section, still have not been thoroughly analyzed.

In the field of structural research, much has been done theoretically, but making the application practical involves considerable work. Greatest progress since the end of the war has been in the development of new means of propulsion. With the creation of turbine and rocket engines came a huge mass of design data and this information is still awaiting full application.

In this connection, new high-temperature alloys, possibly including ceramics bonded to metals, must be developed before the higher compression ratios and the higher combustion heat release inherent in these new engines become felt. Once materials are available capable of withstanding 2000 to 3000 F temperatures while handling stresses of 50,000 to 750,000 psi, all the accumulated data will be able to be put to use and power ratings of new engines will undoubtedly increase tremendously.

Human Heat Tolerance

EXPERIMENTS in man's ability to withstand extreme heat, indicating that approximately 23 min may be the average limit of human tolerance at a temperature of 240 F were reported at the recent semiannual meeting of the American Society of Heating and Ventilating Engineers.

The studies, 21 human exposures to air temperatures ranging from 140 F to 240 F, were made by Craig L. Taylor, associate professor, and W. V. Blockley, research associate of the department of engineering, University of California. Student volunteers were used as subjects for the tests.

The experimental heat chamber was an insulated cylinder, 46-in. diam × 70 in., with a total volume of 70 cu ft. The ventilation and heating were furnished by a blower, a flow-metering system, and a 9-kw electric heat exchanger. The air flowing through the chamber was distributed over its horizontal cross section by a floor baffle-plate system. Its equivalent linear velocity, directed vertically from seat to head of subject, averaged 41 fpm as measured with a thermal anemometer. The ventilation volume rate was maintained as a matter of routine at 70 cu ft per min, exhaust air being discarded.

Air temperature was controlled by a thermocouple-potentiometer system with sensing element in the chamber. Wall temperature remained within 10 F of the air temperature under all conditions. Humidity was not controlled but resulted from outdoor humidity and the moisture added by the subject. Clothing was standardized and consisted of a close-fitting wool-and-cotton one-piece union suit, 0.08 in. thick, with loose-fitting felt duffel socks on the feet.

Before each heat exposure, the student spent at least 30 min resting in a comfortable environment of approximately 80 F, to establish base-line values for various physiological measurements which were checked every two or three minutes. The following symptoms were used as criteria for terminating the tests: appearance of hyperpyrexia and heat exhaustion including faintness, nausea, tingling sensations in extremities, mental confusion, compulsive restlessness, dyspnea, or symptoms referred to the chest when clearly developed.

During four tests, the engineers found that their subjects were able to tolerate temperatures ranging from 237 F to 242 F from 20 to 26 min, for an average tolerance limit of 23.5 min. Six exposures to temperatures of 218 to 224 F yielded tolerance times from 25 to 30 min, for an average of 28 min. At 199 to 203 F, the limit of tolerance ranged from 31 to 35 min in four exposures, with an average of 33 min. The average tolerance limit for four tests at a range of 179 to 181 F was 48.5 min. Two tests at 140 to 142 F were terminated at 63 and 64 min each before the limit of human tolerance was reached.

Research on human tolerance for extreme temperature has long been a practical problem of industrial physiology and hygiene. It has been spurred by the advent of supersonic aircraft which presents the potential hazard of heat to pilots and occupants in the event of failure of the cabin air-conditioning system. Numerous reports from industry of exposure of workmen to searing heat also testify to the need for a knowledge of human limitations, practical measure of personal protection, and for the development of efficient protective equipment.

Electronic Computers

NEW electronic devices and techniques show promise of reducing distribution costs just as power-driven machinery has reduced production costs, according to a recent bulletin of Arthur D. Little, Inc. Electronic clerical machines and computers essentially eliminate arithmetical labor and manipulation of information stored in directories, files, and tables as limitations in business operations. Thus they can both simplify present clerical work and permit control information never before possible.

The first of the now-famous new automatic computers was the IBM Automatic-Sequence-Controlled Calculator, completed in 1944 and presented to Harvard University. Several machines built since then are faster and more flexible, and still others now being built by a number of organizations will make current models obsolete.

Only 26 million people work directly at agriculture, manufacturing, transportation, etc. Nine million are engaged in retail trade, 14 million are in the professions and service trades, and eight million are employed principally in keeping track of the producers' and salesmen's activities. The report points out that if all the repetitive clerical work could be done by machines, the result would be comparable to the advantage of machine tools over hand labor on production. The techniques of electronic computers grafted onto those now employed in such machines as cash registers and automatic accounting machines, and onto devices now under development, such as printers to produce one or two thousand lines per minute, can be used to effect a virtual clerical revolution.

A computer now being developed may be the heart of the Federal electronic all-weather control system for commercial airplanes. This control system is to be installed by 1963 at a cost of $1113 million. An airplane on take-off, will file for a landing reservation with the computer at its destination, and will receive a provisional landing plan, which takes account of weather and other aerial traffic, within three minutes. In flight, the airplane's position is continually reported by radar to the computer, which instructs the airplane to correct any deviation from flight plan. The system will permit landing airplanes at two-minute intervals, instead of ten minutes now needed in bad weather. Without the com-

puter, the calculations involved would be too intricate for such a short time interval.

Economists at Harvard University are using a computer to study the complex effects on industry of any particular upset to the economic equilibrium, such as a decision to enlarge the Air Force.

Electronic computers for pay rolls and other accounting functions are now being produced. They will take data on pay rate, deductions, etc., from punched cards and compute the payment ten times faster than the punched-card machine itself could do it.

Calendars

A PERPETUAL calendar, based on the duodecimal system of numbers, is advocated by The Duodecimal Society of America, in the June, 1949, issue of *The Duodecimal Bulletin*. Popular support of perpetual calendars has largely concentrated on the Fixed International Calendar which divides the year into 13 months of 28 days, arranged in 40 weeks of 7 days each, and the World Calendar (see MECHANICAL ENGINEERING, December, 1940, page 908) which would have a 12-month year of 52 seven-day weeks. The World Calendar has quarters of equal length and identical form, containing 13 weeks, 91 days, with months of 31, 30, and 30 days. Each quarter starts on Sunday and ends on Saturday. Each month has the same number of weekdays, 26, and the 31-day months include 5 Sundays. Intercalary days are Worldsday, December 31st, or W December, and leapyear day, June 31st, or W June.

The World Calendar has been energetically promoted internationally by the World Calendar Association and is receiving active and serious consideration by most nations of the world and by UNESCO. There is a concerted drive for general adoption of the World Calendar by December 31, 1950. A bill for its adoption by the United States is now pending in Congress (S. 1415) and it will be brought before the General Assembly of the United Nations in the session starting this month on a motion proposed by Cuba and seconded by Mexico.

The manifest advantages of the World Calendar involve only minor changes from our standard Gregorian Calendar and it is considered by many that general adoption will be achieved as planned.

1	2	3	4	5	1	2	3	4	5
1	MARCH	30	30	21	7	SEPTEMBER	30	210	17
2	APRIL	30	60	20	8	OCTOBER	30	240	17
3	MAY	30	90	20	9	NOVEMBER	30	270	16
4	JUNE	30	120	19	10	DECEMBER	30	300	16
5	JULY	30	150	19	11	JANUARY	30	330	15
6	AUGUST	30	180	18	12	FEBRUARY	30	360	14

SUN	MON	TUE	WED	FRI	SAT
1	2	3	4	5	6
7	8	9	10	11	12
13	14	15	16	17	18
19	20	21	22	23	24
25	26	27	28	29	30
1	2	3	4	5	6

NEW YEAR WEEK 5|365|

LEAP YEAR 1|366|

COLUMN 3. NUMBER OF DAYS IN A MONTH.
" 4. " " " " SINCE THE FIRST OF THE YEAR.
" 5. THE DAY OF THE MONTH OF STANDARD CALENDAR CORRESPONDING TO FIRST DAY OF MONTH OF THIS CALENDAR

FIG. 2 PROPOSED DUODECIMAL CALENDAR

FIRST QUARTER		
JANUARY	FEBRUARY	MARCH
SECOND QUARTER		
APRIL	MAY	JUNE **
THIRD QUARTER		
JULY	AUGUST	SEPTEMBER
FOURTH QUARTER		
OCTOBER	NOVEMBER	DECEMBER *

S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S
1	2	3	4	5	6	7				1	2	3	4						1	2
8	9	10	11	12	13	14	5	6	7	8	9	10	11	3	4	5	6	7	8	9
15	16	17	18	19	20	21	12	13	14	15	16	17	18	10	11	12	13	14	15	16
22	23	24	25	26	27	28	19	20	21	22	23	24	25	17	18	19	20	21	22	23
29	30	31					26	27	28	29	30			24	25	26	27	28	29	30
																				*W

* Worldsday, (a World Holiday), W or 31 December (365th day), follows 30 December every year.
* * The Leapyear Day, (another World Holiday), W or 31 June follows 30 June in leap years.

FIG. 3 PROPOSED WORLD CALENDAR

The outstanding characteristic of the Duodecimal Calendar, however, is its complete regularity. It proposes that the year start with the spring equinox, as the astronomical year does. The first day of the year is Sunday. The year is divided into 12 months of 30 days each. Each week is of 6 days, starting Sunday and ending Saturday with Thursday omitted. There are 60 normal weeks in the year, 5 in each month, 15 in each quarter. Between the last month of the year, and the beginning of the new year, there is a week of 5 days. This week begins on Sunday and ends on Friday. For leap years, the week has 6 days, ending on a Saturday. This week is alone and is not attached to any month. The Duodecimal Calendar is made perpetual by the omission of the Saturday of New Year's week in ordinary years. In leap years, no omission is necessary.

Each month is like every other month, and so are the quarters. Because of the formal regularity, all dates are readily memorized. For this reason, too, intervals can be calculated with ease. All planning is greatly facilitated.

Greater detail on the Duodecimal Calendar as well as on the other proposed calendars will be found in three brochures published by Louis Paul d'Autremont of The Duodecimal Society of America, 20 Carlton Place, Staten Island 4, N. Y. They are as follows: The Duodecimal Perpetual Calendar, 1926; The Calendar of the Future, 1931; and tables of the Calendars, fourth edition, 1944.

Liquid Impact Punches

AN investigation conducted to determine the practicability of using a liquid instead of metal punches to produce blanks from silicon sheet steel is said to have been concluded with successful results by engineers of General Electric's Works Laboratory in Schenectady, N. Y.

As opposed to the ordinary methods of using a metal punch and die, this method substitutes a column of oil for the punch. The oil can be effectively channeled back and re-used eliminating the use of metal punches which are worn out rapidly on silicon sheet steel.

It is reported that through this method it is possible to use

soft unhardened steel dies which cannot be done with the conventional metal punch. The engineers have determined that for each particular size and thickness of steel, it is necessary to calculate the particular impulse force to achieve a satisfactory blank.

The development of this method, while still in an experimental stage, has indicated that satisfactory blanks can be made.

Nuclear Research Center

THE completion of the Carnegie Institute of Technology Nuclear Research Center, Saxonburg, Pa., marks a new expansion of that school, specifically in the realm of science, with special emphasis for the present on those various fields of physics, chemistry, metallurgy, and mathematics which find a common focus on the newly developing knowledge of the atomic nucleus.

In this Research Center, besides the synchrocyclotron and other equipment used to study the physics of the nucleus, are laboratories for work on the chemical and metallurgical aspects of the problem as well, for scientists have long been aware that their fields cannot be sharply divided and that real progress comes through co-operation. This was emphasized strongly during the last war, particularly by the development of the atomic bomb.

Physically, the Carnegie synchrocyclotron, which is the nucleus of the new center, consists of (1) a 1500-ton steel electromagnet, which resembles a thick hollow box with two sides missing; (2) two squat steel poles inside the magnet, one hanging from the top and the other rising from the bottom cross bars; (3) two pole tips which fit onto the tops of the poles; (4) two 96-ton copper coils, which fit like rings around the poles; and (5) a D-shaped mechanism inside a ten-sided vacuum tank, both of which fit in the space between the pole tips.

In order to give a nucleonic bullet enough energy (that is, ability to work) a machine which can produce a tremendously high voltage is necessary. The Carnegie synchrocyclotron, for example, has a 400-million electron-volt output.

In a cyclotron, particle bullets are guided by magnetic fields, and extremely strong fields are required. In the CIT machine, a magnetic field 40,000 times that of the earth will be used.

When a synchrocyclotron is operating, the real "business" goes on in the D-shaped mechanism inside the vacuum tank between the poles. This is where the particles to be fired are speeded around controlled paths. And it is from this Dee that they are shot out toward the target which may be many feet away.

The poles which are part of the electromagnet, produce a magnetic field in the Dee area, and this magnetic field causes the particles to follow a circular route. When the Dee is negatively charged they will circle and approach the opening again.

These are positively charged particles, hence when they approach the opening the charge of the Dee must be changed to positive so that the particles will be kicked out of the chamber. After the bullets are out, they circle and come back at the Dee again. The process of negatively charging the Dee must be repeated to give them a boost into it; then the positive is turned on again to push them out. This alternation is continued as the particles spin around, giving the bullets a shove each time they enter and leave the Dee, consequently causing them to move ever faster.

As the particles gain speed they travel a wider circle. But when they approach the speed of light, they start to become heavier, causing the time period from the moment they are pulled into the Dee chamber to the moment they are repelled to become longer and longer. This means the Dee charge must be changed from negative to positive and vice versa less and less frequently in order to catch the bullets just when they are entering and leaving.

By a synchronization operation, a correction is automatically made to the frequency of charge change so that it remains in step with the motion of the particles. For this reason such machines are sometimes called frequency-modulated cyclotrons, although the name synchrocyclotron is now most commonly used.

When the particles in the Dee, traveling close to the speed of light, reach the outer rim of the Dee circle they will fly through a part called a deflector, and then will rush like a guided missile with high energy toward the target.

With the new Carnegie synchrocyclotron, it is hoped that the following types of information will be obtained: From experiments on scattering of protons by protons, knowledge of the force that holds the particles together in a complex nucleus and how the force varies with the distribution between the particles will be sought. Research will be conducted to learn the relationship of mesons to the internal structure of the nucleus by measuring the number of mesons produced by various types of nuclear collisions and by studying the distribution of these mesons from various angles. From careful measurement of the mass and the angular momentum of the mesons it is hoped to learn more of the intrinsic laws of nature which govern the existence of various fundamental particles.

Technical Dictionaries

THE interchange of technical information between nations depends in no small measure upon accurate translations, which can be done only by fully qualified translators, aided by technical dictionaries, writes P. E. Erickson in the July 1, 1949, issue of *Engineering*. Mr. Erickson points out that there is no lack of technical dictionaries, but the trouble is that few of the more important ones are up to date. The rapid progress of science and technology brings forth new discoveries and inventions, for which new terms and expressions are needed. On the other hand, the preparation of dictionaries is a slow and exacting procedure, which, particularly in the case of multilingual text, may take years to complete. Some translators resort to the expedient of compiling private lists of new words, but even so, may encounter the difficulty that a newly coined word may not have an equivalent in other languages. In this article some comments and suggestions regarding the planning of technical dictionaries are offered by Erickson.

A recent survey of 50 technical dictionaries has brought to light some information which may be of interest. The majority of them (80 per cent) were published before 1939, and of these, 35 per cent comprise three or more languages. Generally speaking, these dictionaries are largely devoted to heavy engineering and technology. One notable exception in this category is the "Vocabulaire Téléphonique International" on telecommunication, published in 1938 by the Comité Consultatif International Téléphonique. Prominent among the multilingual dictionaries are those compiled by Dienhardt-Schlomann (1910) and the Schlomann-Olderbourg (1920), which together cover practically the whole field of civil and mechanical engineering. In 1928 Schlomann brought out a companion volume on electrical engineering and electrochemistry. The languages included are English, French, German, Italian, Russian, and Spanish. The most valuable feature of these works is that wherever necessary, illustrations of the objects described are inserted in the text.

Another eminent work in this class is the "Dictionary Tech-

nique Illustré," in Dutch, English, French, German, Italian, and Spanish, which was started in 1932 under the auspices of Association Internationale Permanente des Congrès de Navigation. The Association appointed experts from academies and institutions in the countries concerned to serve as an editing committee. The members of this committee gave their services gratuitously, but the cost of publication was borne by the Association. The whole work was planned to comprise 15 volumes, each dealing with a particular phase of the maritime art. Up to 1939 five volumes were published.

The survey further disclosed that prior to the war, relatively few bilingual dictionaries were published. One might infer that existence of many excellent multilingual dictionaries during that period made the production of bilingual dictionaries somewhat redundant. The postwar tendency, however, appears to favor the latter class of dictionaries. It is appreciated that such dictionaries can be produced much more quickly and at less cost than multilingual ones; also, that time is an important factor when new words and expressions are to be caught in flight, so to speak. Without listing the ten bilingual dictionaries examined, it may be said that with one exception, they were all published since 1944, and the majority are of good quality. They are restricted, however, to English, German, Italian, Polish, Spanish, and the Scandinavian languages, and only one of them gives any illustrations.

Reference was made to dictionaries compiled by international associations. There is a good deal to be said in favor of this method. Experts from various countries, who are members of such bodies dealing with technical problems, meet periodically to discuss them at international conferences. It is suggested that advantage could be taken of such occasions to consider the advisability of preparing technical dictionaries on the subjects with which the particular body is concerned. For example, it is conceivable that the World Power Conference could appoint a committee for that purpose, much along the lines of the action taken in 1932 by the International Navigational Association. Another method would be that the major technical institutions of the more advanced countries might co-operate in the production of up-to-date dictionaries. Each institution could appoint some recognized authority to deal with his subject in collaboration with his opposite number in the technical society in the other countries participating in the work.

The relative merits of multilingual and bilingual dictionaries are frequently discussed. Apart from the question of cost, which has to be balanced between, say, one six-language dictionary and six bilingual ones, other considerations arise. One very important requirement for a dictionary is that of easy reference. The big polyglot dictionaries are very useful as final arbiters, but the busy translator needs a quick method of finding the word he needs. Owing to the double entries in the make-up of dictionaries of this kind, he is obliged first to look for the required word in the alphabetical index and then, by means of a number or page reference, locate it in a separate subject section. In the very nature of things the illustrated encyclopedic form of such works tends to be rather bulky. The experienced translator usually finds it more convenient to use a bilingual dictionary and to consult the multilingual one in doubtful cases.

From the translator's standpoint, a good technical dictionary should fulfill the following requirements: It should give, as far as possible, an ample choice of alternative meanings, since the same word can have entirely different meanings in different branches of the art. The gender of a noun should always be indicated. For the benefit of those who are not skilled linguists but may have occasion to consult a technical dictionary, it would be an advantage if the past participles of verbs were given in the alphabetical index. Such participles are sometimes used as nouns and can have a slightly different meaning from the original verb. All dictionaries should give a comprehensive list of abbreviations in common use. Many of them give only the particular abbreviations used in compiling the dictionary, but omit those in general use. Even the most talented translator cannot be expected to know the significance of a multitude of abbreviations used in other countries. The large encyclopedic dictionaries should adopt the practice of the main general dictionaries (such as Harrap's French-English and English-French dictionaries) which give illustrative phrases and idioms. A word is often used in an idiomatic sense which is not clear from the context nor from a mere dictionary definition. The compilers of some otherwise excellent dictionaries use a cross-reference method which tends to slow down translation work.

According to Mr. Erickson, the existing multilingual dictionaries might be modernized and made more useful by the introduction of some of the foregoing suggested improvements. In view of the relatively high cost of these works and the time taken to produce new and complete issues, it would be well if the authors and publishers were to produce less expensive supplements, say, every two years. This would give the editor an opportunity of introducing new words without having to revise the whole work. A good example in this respect is the latest edition of the "Encyclopedia Britannica," which is perpetuated by a Year Book, keeping the whole work up to date. The language of technology is a living and growing thing which is worth cultivating for the sake of clarity and understanding.

Mechanical Kidney

AN improved mechanical kidney of the type invented in 1944 by Dr. W. J. Kolff of Holland, has been developed and is being produced by the Allis-Chalmers Manufacturing Company, Milwaukee, Wis.

Built of stainless steel, the mechanical counterpart of the human kidney is about 51½ in. long, 42 in. high, and 24 in. wide. It consists of a perforated drum which rotates at 18 rpm and is partially submerged in a bath rinsing fluid containing primarily electrolytic salts. Both drum and bath are constructed of aluminum covered with a type of Vinylite. The unit is powered by a ¼-hp single-phase motor.

The drum is spiraled by about 140 ft of cellophane tubing through which the blood flows as the drum rotates. This tubing is actually sausage casing which permits certain sized molecules to flow through its walls. As the blood travels through the tubing, passing along always below the level of the bath water, the poisons, due to their molecular size, seep through its walls into the rinsing fluid. This fluid must be changed every two hours to keep its poison concentration below that of the blood. The seepage of poison through the cellophane tubing from high to low concentration cleanses the blood.

Interesting features of the new unit include a safety device for by-passing the blood in the event the cellophane tubing should tear, a clutch appliance which permits the drum reel and pump to run separately, ±1 deg thermostatic control of the bath, a plastic cover for maintaining even temperature, and a hypodermic syringe which provides a rotating or slip-ring type of joint.

To form the rotating joint, the ends of a hollow plunger in a hypodermic syringe were cut off, making the plunger a tube and the stationary member of the joint. This joint is fastened to the tube which leads to the patient. The body of the syringe rotates with the drum and is connected to the cello-

FIG. 4 KOLFF TYPE ARTIFICIAL MECHANICAL KIDNEY

phane to provide an effective nonmetallic seal for the two rotating joints.

The mechanical kidney provides two pumping actions—one a pressure produced as the blood is worked along the bottom sections of the spiral winding by the drum's rotation; the other a milking action of a Beck-type pump which returns the blood to the level of the patient. This latter action is accomplished by three cylinders mounted on a rotating unit which squeeze the tubing within the pump housing and at the same time roll the blood ahead of it. Capacity of the pump varies 250 cc per min depending upon the application. It changes the blood in the kidney completely about every two minutes.

Capable of replacing the functions of the human kidney for several hours where acute uremic poisoning exists, the mechanical kidney has been known to remove enough poison in 10 hr to permit the patient to live eight or ten days without further application of the machine. While the blood flows through the mechanical unit, which is held within one degree of body temperature, it is kept from clotting by heparin.

Radiation-Measuring Instrument

PROGRESS on an instrument which will measure radiation in air more than 70 miles above the earth's surface has been reported by Dr. Severin Raynor, senior scientist at Armour Research Foundation of Illinois Institute of Technology, Chicago, Ill.

Scientists plan to measure heat radiated from the sun, the earth, and space with a gyrostabilized sphere which will be ejected from a rocket on its way up at a speed of about 1800 mph. The metal sphere will contain three gyroscopes, 14 temperature sensors, and a camera unit for recording the data to be studied later.

"This phase of upper-air research is expected to add to fundamental knowledge—the kind of things a man on a trip to the moon would need to know," Dr. Raynor said. He cited the desire for more information about the climate encountered by rockets for both civilian and military use.

The project at the Foundation is being sponsored by the U. S. Air Force Air Materiel Command.

Describing space 400,000 ft high, Dr. Raynor said it is dark and hot (about 180 F). An almost complete vacuum prevails and weight decreases.

The radiation-measuring spherical instrument is in the final stages of development. Major problems in the development have been stabilization and suitable instrumentation. Armour scientists are now designing supporting rings, or "gimbals," which will allow the sphere to remain stable in flight and to be ejected from the rocket.

The gyroscopes keep the sphere stable both inside the rocket and after it is ejected. The sphere, which resembles a large cannon ball, can turn inside its supporting rings to do this, rotating on three axes. The effect of the rocket's spin is reduced by mounting the gimbals and spheres on a platform which oscillates around the axis of the rocket itself.

An experimental "cannon ball" was floated in mercury and stabilized in the laboratory by a brute-force system of gyroscopes against forces expected to disturb the instrument's stability in practice. Scientists allowed for a rotation of only five degrees.

The rings supporting the sphere consist of halves held together by hollow explosive bolts. After the cannonball (or sphere) containing the measuring equipment is ejected from the side of the rocket in flight the bolts are set off electrically and the gimbals are stripped from the sphere. The sphere then falls free in space while measurements are made.

The radiation-measuring device consists of 14 buttons located on the surface of the sphere. Each button contains a thermocouple, or temperature sensor. These temperatures are recorded on 16-mm film using a specially designed slow-speed camera. A watch mechanism times the recording.

The gas-tight camera, with its record on film is ejected from the cannon ball as it falls. A 400-megacycle transmitter attached to the camera allows its fall to be tracked by radio. A ribbon parachute controls its fall and aids in recovery.

Coke and Coal Chemicals

THE annual canvass of coke producers in the United States, conducted by the Bureau of Mines, Department of the Interior, showed that more coke was produced in 1948 than any time in the history of the industry. The 1948 production amounted to 74,861,928 net tons; this was 1,416,078 tons (2 per cent) more than in 1947, and 824,111 tons (1 per cent) more than the wartime peak in 1944. Although output of beehive coke declined 109,730 tons, production at oven-coke plants was 1,525,808 tons more than in 1947.

The quantity of coal carbonized in coke ovens was also the greatest on record; but the quality was not up to the usual high standard because a large proportion of inferior coal was purchased in the first part of 1948 in anticipation of interruptions in coal production. As a result, the yield of coke per ton of coal dropped from 69.91 per cent in 1947 to 69.60. Coal purchased in the latter part of 1948, however, was much better for coking and the yield of coke should improve in 1949. Coal costs at the ovens reached new peaks in 1948 because of increases in mining and transportation costs. The average value of coking coal at oven-coke plants increased $1.35 per ton over 1947, and at beehive-coke plants, $0.68 per ton. The rise in coal costs resulted in increases in coke prices and the average value per ton of all coke sold on the open market advanced as follows: Furnace coke, $2.68; foundry coke, $3.81; water-gas coke, $2.25; other industrial coke, $2.37; and domestic coke, $1.98.

The heavy demand for metallurgical coke (blast furnace and

foundry) continued in 1948 and 63,036,165 tons were consumed for this purpose, or 85 per cent of all coke sold and used by producers; 7,733,382 tons, or 10 per cent, went for other industrial uses; and 3,445,309 tons, or 5 per cent, for domestic heating. Coke for household use has declined markedly since 1940 when 14 per cent of all coke sold was so used. Despite the increased consumption of coke in 1948, producers' stocks at the end of the year amounted to 1,593,441 tons, an increase of 561,204 tons, or 54 per cent.

Production of the principal coal chemicals increased in 1948 although yields per ton of coal carbonized decreased because of the poor quality of the coal charged and the high rate of oven operation. Tar production increased 2,580,626 gal over 1947; ammonium sulphate or equivalent, 34,763,170 lb; gas, 23,590,346 M cu ft; and crude light oil, 1,110,602 gal. The total value of coke and breeze produced and coal-chemical materials sold in 1948 reached an all-time high of $1,230,234,113.

200-Hp Gas Turbine

A SMALL gas turbine can be a neat and simple machine, according to an article by S. D. Hage, Boeing Airplane Company, Seattle, Wash., appearing in the *Aeronautical Engineering Review*, July, 1949. The model developed by this company and described by Mr. Hage, is a 200-hp gas turbine consisting of a single-stage centrifugal compressor with two outlets, two constant-pressure burners, and a compressor-driving turbine. This primary stage, or hot-gas producer, has a rated speed of 36,000 rpm and drives the accessories. The secondary or power-output stage consists of another turbine with a rated speed of 2500 rpm. The speed of the primary stage is entirely regulated by the load and can be varied from stall to runaway or maximum safe speed.

The weight of the engine without accessories is approximately 150 lb. The power output will vary between 100 and 200 bhp, depending on the endurance life expected. The rated specific fuel consumption will vary between 1.5 and 1.0 lb per bhp-hr, depending on the rating and the degree of component refinement possible. Mr. Hage claims that the engine is extremely easy and consistent to start; it can develop rated power 15 sec after the start is initiated; it can accelerate rapidly, going from idle, which is about 10,000 rpm, to full speed in 5 sec; it is practically vibrationless if the rotating parts are accurately balanced; it is destructively rough if not.

Offsetting some of the desirable features of a small gas turbine are the following features: The air consumption is extremely high, and large intake and exhaust friction losses are not tolerable. A clear solution to the compressor-inlet noise problem has not yet been solved. This silencing problem is especially difficult because of the large flow and the necessity for extremely low pressure drop. The idle fuel consumption is high, roughly one fifth full power consumption. The development cost is high. This is primarily the result of having to solve so many new problems along with the general run of mechanical problems that plague any new piece of machinery.

A comparison of the 200-hp gas turbine with a 350-cu in. air-cooled aircraft engine, both rated at 160 bhp sea-level static, showed a reduced power loss with altitude and an increased power gain with ram for the gas turbine.

A comparison between the gas turbine and the air-cooled engine in a light airplane was made. The gross weight has been fixed at 2500 lb; the drag area at 3 sq ft; the span loading at 75 lb per ft; the fixed-pitch propeller diameter at 7 ft. The superior ram and altitude characteristics of the gas turbine result in considerably improved high-speed performance. The superior output torque characteristic of the turbine results in considerably increased thrust for take-off and climb. The engine weight differential is 200 lb in favor of the gas turbine. Estimating the cruising specific fuel consumption of the gas turbine at 1.5 lb per bhp-hr and the piston engine at 0.6 lb per bhp-hr, this 200 lb would be eaten up by fuel in about 3 hr.

Production costs are unknown, said Mr. Hage, but it seems most reasonable that they will be less per horsepower than reciprocating engines. Available information on one of the large American turbojet engines indicates an engine cost of about $11 per lb. This is less than the cost of aircraft piston engines designed to the same weight and life standards. In addition, the prospects for future improvement through development are excellent, both as to fuel consumption and power-weight ratio. Component refinement will pay off in both. The use of regenerative heat exchangers will pay off well in fuel consumption at the expense of power-weight ratio.

Aluminum Die Casting

A DIE-CAST aluminum automobile door, said to be the largest die casting in area ever produced, is now being manufactured by the Doehler-Jarvis Corporation of New York, N. Y.

The die casting, which is made of a special aluminum alloy, forms the structural base of the automobile door, to which the sheet-steel outer panel is attached. It covers an over-all dimensional area of approximately 1200 sq in. (it is 43 in. long × 33 in. wide) and weighs slightly more than 12 lb when trimmed. The die used in producing this door weighs approximately 13 tons, and the trimming die weighs more than four tons. Molten aluminum alloy making up this door is shot into the steel die in something less than one fifth of a second. External pressure required to force the metal into the die is measured in thousands of pounds per square inch.

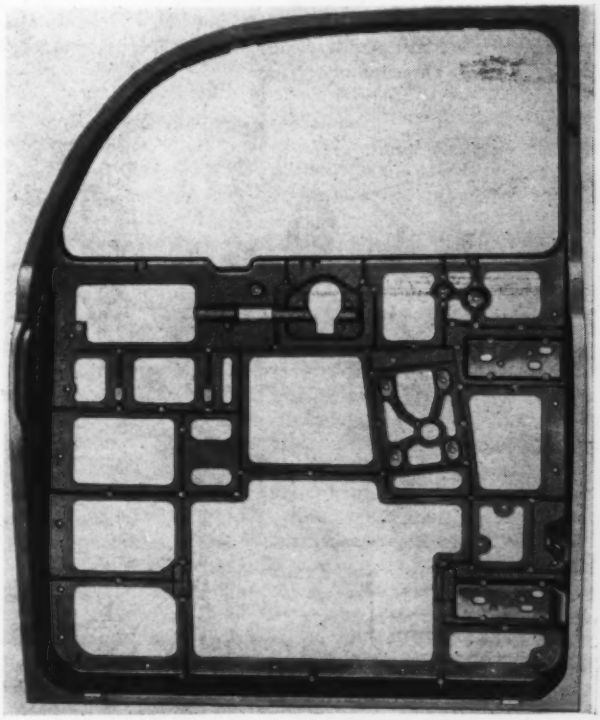

FIG. 5 ALUMINUM DIE-CAST AUTOMOBILE DOOR FRAME

The die-cast aluminum door reduces the weight of a four-door car by approximately 35 lb.

Some of the characteristics of the aluminum die-cast door are as follows: The aluminum die casting enables the designer to make free use of reinforcing ribs, which are difficult to obtain in sheet-metal practice; these die-cast frames will conform to shape and free the final door product of the annoying variations encountered in sheet metal; because of the rigid aluminum die-cast structural frame, the composite door lacks the tinlike sound of the sheet-metal door.

From a production standpoint, the die-cast door is expected to eliminate one of the bottlenecks of the assembly line. Time lost in hand-fitting doors should be eliminated and consequently speed up production, and effect a substantial savings in assembly costs.

In addition to its lightness, the special aluminum alloy used in the door has a corrosion resistance without special treatment, is free from dimensional changes, and retains all original properties at subnormal temperatures.

Man-Au-Trol

RECENTLY emphasis has been placed on making machine tools as automatic as possible. One development along these lines is the Man-Au-Trol, invented by E. P. Bullard, 3rd, and described by L. J. Baudis, at the 1949 ASME Spring Meeting, held in New London, Conn.

The Man-Au-Trol equips a machine with all the controls that are normally supplied by the operator. Mr. Baudis said that the controls are much superior since the mechanism works tirelessly hour after hour, day after day, at the highest efficiency in feeds and speeds, always performing the operations in the best manner and in identical fashion, never making errors, and always producing accurate work in a predetermined measured quantity.

This control is achieved by a combination of co-ordinated mechanical, electrical, and hydraulic elements. It is composed of the following three major sections:

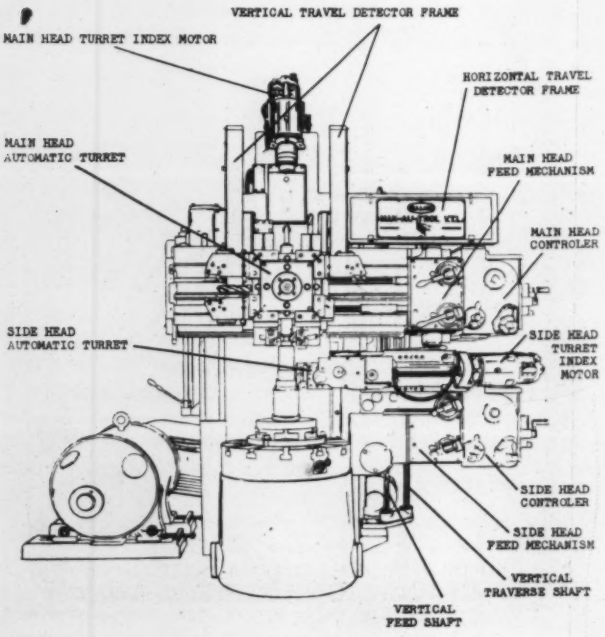

FIG. 6 VERTICAL BORING MILL

1 Function control drum, which is readily set up to control any desired series of operations. This could be compared to that portion of the brain or memory of an operator which determines "what" the machine shall do.

2 Detector switches and control blocks, which establish "when" and "where" the various functions are to take place. These might be compared to the eyes and nerves which normally tell the operator the status of the machining operations and determine the time and the place for a change in the operations.

3 Power system, which engages clutches and gears, starts and stops spindles and motors, and operates other controls for running the machine. This could be compared to the muscular system of an operator.

The Man-Au-Trol, in automatic setting, functions as follows: (See Fig. 6)

1 After loading, operator pushes start-cycle button. Control drum indexes to No. 1 function. The hydraulic system engages selected clutches.

2 Head will move in accordance with the setting on function No. 1 on the control drum.

3 When No. 1 detector switch is contacted, an electric circuit is closed to energize a solenoid valve. This causes a hydraulic shuttle valve to exhaust the active clutch cylinders thereby neutralizing the clutches and terminating the motion of the head for function No. 1. The control drum then indexes and machine operates in accordance with setting on function No. 2 until No. 2 detector switch is closed.

4 The same procedure described for function No. 1 occurs until all the active functions are completed and the machine returns to the start condition and then stops for loading. The drum then indexes rapidly through the spare functions to the zero position.

The Man-Au-Trol also provides for completely manual operation, and at the turn of a lever the machine can be operated as a conventional lathe. To simplify setting up, an automatic stop feature is incorporated. It is used primarily for checking sizes and adjusting tools in setting up the automatic cycle. When the lever is turned to the automatic stop position, the control will allow the machine to continue in the operating function until it is completed and it will stop the head at that position.

The function control mechanism is mounted on and works in conjunction with the machine feed bracket which controls the motions of one of the heads.

After a careful study of applications to vertical boring mills, the Man-Au-Trol was designed for 39 functions for each head, consequently, the drum has a starting position and 39 functional positions. See Fig. 7. Each has a series of drilled and tapped holes along a horizontal line; these are used to attach control dogs which will specify the operations in the desired sequence.

For example, if the first function of a vertical turret-lathe head is to be traverse down, one of the control dogs is secured in the traverse-down position as indicated on the function control plate. Function 2 may be feed down at a rate of 0.015 in. A check of the feed chart reveals that for this rate of feed, dogs must be attached to C and 2 positions. Therefore on line 2, three dogs would be attached, one on feed down, one on feed letter C, and one on feed number 2. Function 3 may require a turret index and a dog would be placed on line 3 in the turret-index hole.

In similar manner, all the operations required to machine the part in the best sequence are set up on the drum. Naturally, any of the 39 functions which are not required are left blank. The machine performs no needless functions because these spares are skipped entirely.

When in automatic cycle, the functions recorded on the drum are put into effect by the indexing of the control drum which consecutively brings the functions into the hydraulic valve and switch operating position. Only one of the functions is effective at one time. In the operating position, all dogs mounted for that function act through levers which operate hydraulic valves or close electric switches.

When hydraulic valves are operated, they serve to open paths for oil at 500 psi pressure to flow through the manifold and connecting tubes to pistons which engage gears or engage clutches in order to provide a positive gear, shaft, and screw mechanical drive. When electric switches are operated, they close contacts to provide electric power to turret-indexing motors or speed-changing controls and other electrically powered machine elements.

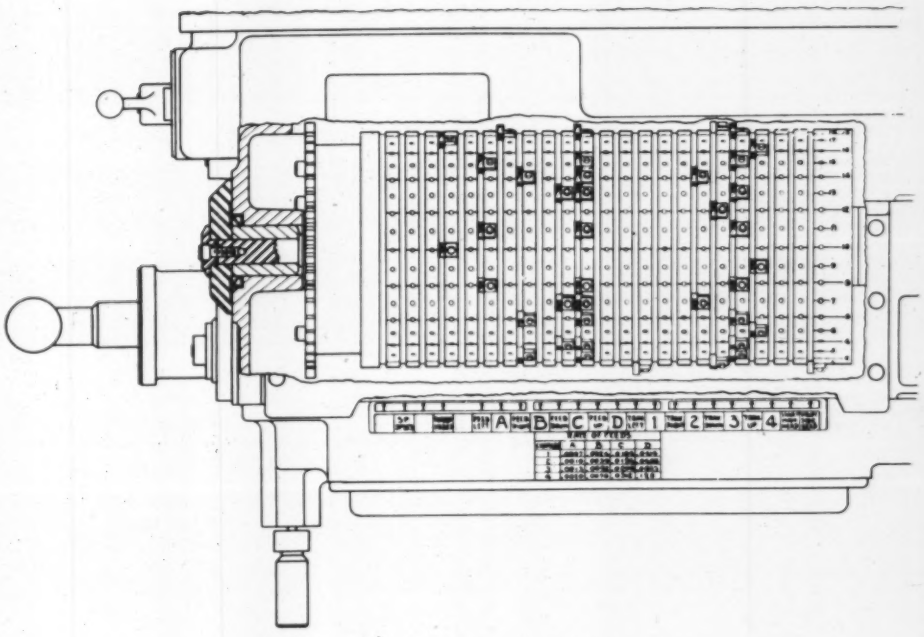

FIG. 7 MAIN HEAD FUNCTION DRUM

Casein Fiber

A NEW curled casein fiber is now being used where the resiliency of horsehair previously had been uniquely suitable, according to the July, 1949, *Industrial Bulletin* of Arthur D. Little, Inc., Cambridge, Mass. The new fiber, known as Caslen, and used as a single filament a few thousandths of an inch thick, is cheaper than the best-quality horsehair, equally resilient, and much more dependably uniform and available. The process was suggested by work of the Department of Agriculture, and was developed for these applications by Arthur D. Little, Inc., and the Rubberset Company, which is now producing Caslen.

Casein, obtained from skim milk, is one of the proteins. When "regenerated" in fiber form it will take a permanent curl which gives a mass of fibers a springy quality. Mattress and furniture manufacturers are experimenting with Caslen as stuffing. In an uncurled form which is also available it may be blended into textiles to produce novel effects.

When skim milk is solidified by hydrochloric or other acids, the casein settles out as a curd. The casein is dried, water is added, it is heated, and forced through fine jets. The resulting filament is hardened in a tanning agent such as formaldehyde, curled, and dried to a permanent set. The curled casein monofilament is now selling for 94 cents per lb, but the price may decline as production increases and the price of dry casein drops. Horsehair sold at $1.25 to $1.40 per lb in 1948. Besides its favorable price position, the curled casein is uniformly clean, the diameter and length of the staple are controllable, and it is believed to be nonallergic. Cleanliness is a particularly important point for mills handling large quantities of fiber, for the natural materials are often heavily contaminated. The filament may also be treated to make it mildew, moth, or bacteria proof. The success of the new product as an improvement over natural horsehair is expected to give impetus to the whole field of filaments and textiles from regenerated proteins.

Curled Caslen is now used in a new automotive air filter made by Fram Corporation. Caslen, blended with wool, filters dust from the air entering the carburetor. The filter unit can be used in old cars as well as new and can be replaced more easily than the oil in conventional filters can be renewed.

Large Phenolic Moldings

ACCORDING to the June, 1949, issue of *Durez Plastics News*, the year 1949 will be marked on the calendar by historians of the plastics industry as a period during which old conceptions of size limitations for compression-molded pieces were abandoned by progressive engineers. After a steady upward trend in size during 1948 and the early months of 1949, Molded Products Corporation recently announced production of a one-piece, 35-lb, phenolic-plastic, television console cabinet for the Admiral Corporation.

In almost every case where a big plastic housing or part has been utilized, the cost of the final product has been reduced. In the case of the Admiral console, the retail price of the plastic-housed model is approximately $100 below that of comparable sets with wood cabinets.

Besides its proved ruggedness, other advantages of the plastic from the consumer point of view are its immunity to alcoholic and other beverages which may be spilled on it, and its resistance to burning should a lighted cigarette or cigar be dropped on its surface. Further, the finish is practically marproof, since it is an integral part of the cabinet rather than an applied coating.

A 30-ft-high compression-molding press is used to supply the 4,000,000 lb of pressure which is required to mold the big console cabinet. Built by Bethlehem Steel during the war for the Russian government, the big press was never picked up. Molded Products Corporation purchased it from an Akron, Ohio, machinery dealer. It was shipped piecemeal to Chicago, and twelve weeks were required for installation and assembly.

A 75-hp motor operates the powerful oil pump which supplies the hydraulic pressure to operate the press. Because of this hydraulic operation, the enormous pressure exerted by the

press is built up slowly, thus allowing the gas and air to escape from the mold before hardening of the softened plastic begins to take place.

Other data on the press are: molding stroke, 60 in.; maximum press opening, 128 in.; molding bed dimensions, 96 in. on each side; clearance between pillars, 54 in.

Starting with flawless castings, the various parts of the mold were first rough-tooled to approximately their final shape. Then hand finishers brought them to their final state of perfection. Each part was then case-hardened by "soaking" in a cherry-red bath of bone charcoal.

Several of the finished pieces were then assembled together on a back plate to form the mold insert section or bottom die. This section forms the front outside surface of the console, being mounted stationary, face up on the molding bed of the hydraulic press.

Two other pieces were bolted to a second back plate and clamped to the press ram to form the plunger section or male die, which applies the pressure generated by the hydraulic pump. This male die is deliberately left slightly rough so that the finished cabinet will stick to it, thereby being extracted from the cavity when the press ram is raised upon completion of the molding operation.

The third section of the mold, weighing 6000 lb, is a massive cavity which shapes the top, sides, and bottom of the console. In order to withstand the tremendous pressures built up during the molding operation, the walls of this cavity are nine to ten inches thick.

The mold complete with back plates and die supports, weighs about 20,000 lb.

The actual molding process employed follows closely standard compression-molding procedure, with the exception of being on a much larger than normal scale. Seventy half-pound preforms or "bricks" of the phenolic material are first brought up to molding temperature in a high-frequency electronic preheating machine. When the preheating is completed, the mold cavity is cleaned out with a high-pressure air blast and the "charge," totaling 35 lb of molding material, is carefully loaded in the bottom of the mold. The press is then started in motion, and the plunger section starts its descent into the cavity. The time required for the complete cycle is seven minutes.

As the plunger comes into contact with the heated preforms, it slows to a crawl and begins building up the tremendous pressure required to liquefy the molding material and force it into every crevice of the mold. Once this is accomplished and the mold is fully closed, the baking period begins, during which the combination of heat, supplied by high-pressure steam circulated through cores in the mold, and pressure completes the polymerization of the phenolic compound, and changes it into its final hard infusible state.

After this baking period, which consumes approximately 3½ min, is completed, the plunger is extracted from the mold cavity, bringing with it the completed one-piece console. This is immediately removed from the plunger, and the cycle begins over again.

The cabinet, complete in every detail, including the center shelf which supports the television chassis, is ready for assembly after the thin flash, which forms around the mold parting line and in the grillwork, is removed.

Electronic Contour Control

A NEW electronic instrument, which can follow the lines of a drawing with an electric eye and guide a machine tool to cut out metal parts according to the drawing, has been announced by General Electric's Special Products Division.

Designated as the G-E "contour following system," the new device is connected to a machine tool so that the machine's cutting tool reproduces in metal the drawing "seen" by the electric eye. As the "eye" moves along the lines of a drawing, the position of the cutting tool is changed accordingly by means of an electronic servosystem, which emits signals to control the lead screws of the machine tool.

This unique contour control was developed to solve an unusual problem of machining irregularly shaped metal parts which are difficult to make by normal hand-controlled machining methods. The equipment has not been applied to ordinary manufacturing processes, according to G-E engineers, but it is expected to find application in fields where small quantities of relatively expensive pieces must be produced to close tolerances. In the use of the system, an exceptionally accurate drawing is reproduced on a metal plate. The control then operates to guide the machine tool in accordance with the lines on this plate, thus eliminating much of the layout time, as well as the need for templates or patterns.

The equipment is capable of following a line in the form of a closed loop with a diameter as small as 0.06 in., G-E engineers said. It scans the line of a drawing through a low-power microscope at a speed of 0 to 6 in. per min. When the line is in the center of the microscope's field, the eye sends out an electrical signal at a frequency of 60 cps. A 26-tube electronic circuit picks up this signal. If the phasing varies, the line is not in the center of the field, and the circuit instantly sets mechanical guides into motion to bring the eye and microscope back into position. The instrument does not vary from the drawn line by more than 0.003 in., according to its designers.

The microscope and the electric eye are placed on a movable mount, which rests on a lathe bed. The drawing to be reproduced on metal is set a fraction of an inch from the microscope on another movable mount. When the line to be followed travels to the left or right, the microscope and eye move in their mounts to follow it. When the line travels up or down, the drawing itself changes position. These motions are transmitted electrically to the controls on the machine tool.

A set of change gears provides a range of reduction ratio between drawing and finished part from 3.75–1 to 60–1. Thus the relative dimensions of a basic shape can be distorted in two dimensions by small incremental alterations on the control panel. Also, because of this range of reduction ratio, the error in the finished piece is less than 0.001 in.

The power required to operate the equipment is 220 volts, 60 cycle, approximately 20 amp. It will perform satisfactorily within an ambient temperature range from 65 to 104 F.

Neurosurgery Drill

A NEW pneumatic drill, manufactured by the Aro Equipment Corporation, Bryan, Ohio, and especially designed for use in surgery of the brain and spinal cord, was presented and demonstrated to the members of the American Academy of Neurological Surgery at their annual meeting in Montreal, Canada. The tool is small and convenient in size, with ⅛-in. drill capacity. It is equipped with a protector sleeve that covers the complete tool including the chuck, thus allowing the tool to be used close to the working area without rotating parts touching the open wound. The sleeve is slotted to give a spring effect and is put over the chuck to stop pins inserted through the muffler. A pistol-grip handle is locked into position with a set screw, and the handle may be removed to operate the drill as a button tool if desired.

Another practical feature for easier handling results from

having the intake at the rear of the tool instead of at the bottom of the handle. It can be used with either air or nitrogen and can be sterilized in the autoclave. The gas under pressure used to drive the tool must be sterile when it reaches the tool. Prof. E. G. D. Murray, of Bacteriology at McGill University, designed a special filter which stops all bacteria regardless of the gas source. It is a cylinder filled with disks of Pyrex glass wool.

After each operation, the tool is flushed with kerosene blown through it under pressure, sterilized by steam at 270 F in an autoclave, and then reoiled with sterile oil.

The drill is used for an average of five minutes at each operation and the neurosurgeons who have used it say it is a gentle, controllable, dependable, safe instrument. A wide variety of drills and saws can be used in it, including right-angled attachments. The explosion hazards are less than in electrically driven tools, an important point in operations where anesthetic agents used are combustible.

Surface Finish

A PAPER, "Surface Finish Requirements in Design," was presented by James A. Broadston, Aerophysics Laboratory, North American Aviation, Inc., Los Angeles, Calif., at the 1949 ASME Semi-Annual Meeting in San Francisco, Calif., in which the present needs, knowledge, and standards of surface finishes were discussed. The paper is to make up a section in the forthcoming ASME Metals Engineering Handbook.

It is pointed out that the growth of mass-production methods and improved manufacturing techniques have made commonplace the preparation of surfaces whose perfection exceeds that dreamed possible a decade ago. Mechanisms of great complexity and precision are now designed and built that are wholly dependent upon the precise control of surface finish for their successful life and operation. While surface finish has always been a factor of importance in the manufacture of machinery it is only recently that it has grown to a point where it is a vital design consideration as well.

Mass production and the resulting trend toward specialization has reduced the relative number of all-round skilled craftsmen to the point that most shops employ a host of machine operators whose judgment and experience with surface finishes and their application is quite limited. Such operators seldom know or understand the exact function of the parts being manufactured. The only information at their disposal is that given on the drawing and that information, in many cases, is woefully inadequate from a surface-finish standpoint. As a result, surface finishes are controlled in many shops only through a series of trials and errors. Parts are made, assembled, and tested. Many product failures that occur in final performance tests are found to be the result of improper surface finish even though these parts have been previously inspected for conformance with close dimensional tolerances. In most cases the corrective procedure consists of advising the machine operator that a better finish is required on future parts and reworking the defective parts if possible. This is at best an expensive procedure that must be frequently repeated in order to maintain product quality. From such a procedure an ability to define surface-finish requirements and designate them simply and clearly on the drawing seems an essential to future progress.

Only the designer, the creator of the new mechanism, can be expected to know from his experience with previous designs and his knowledge of the performance he demands and can expect to realize through the controlled application of improved surface-finishing processes, which surfaces of each part are critical and must be given special design consideration from a surface-finish standpoint. With this knowledge the designer must be able to specify on the drawing (or in the specification in some definite manner) the required finishes with sufficient precision to assure that the parts, and therefore the entire mechanism, will function properly.

From a design standpoint it may be just as unsound to make a surface too smooth as it is to make it too rough. Unless the smooth finish is necessary costs are excessive. If the surfaces are too rough, it is possible that performances and life may be jeopardized. Whenever parts roll, slide, turn, rub, make contact, or rest upon one another, surface finish becomes an important factor in design. Surface finish therefore not only affects the economics of proper design but also influences the lubrication, friction, wear, life, performance, strength, and dependability of a given mechanism.

The attainment of proper surface finish has been and always will be important. The fact that so little surface-finish-design information is given in most handbooks serves to prove that it is only recently that the responsibility for its control has shifted from the shop to the engineering department. Even today it is impossible to specify, except in general terms, the optimum finishes for given classic types of machine components. This is because the state of the art is such that although key men in each industry know from years of experiences which finishes will perform satisfactorily in any given application in their own field these finishes have not been systematically measured by modern methods and the results tabulated by any agency. It is predicted that the day will come when all basic design sketches in handbooks will not only include reference to acceptable tolerances but also acceptable and optimum surface finishes since a knowledge of both is rapidly becoming essential to proper design.

Modern instrumentation has implemented the measurement of surface finish to the point that the designer can now evaluate the performance of certain known standard degrees of surface finish under given operating conditions and from this performance may be able to specify the proper finish for the future production of items operating under similar conditions. Not only can the finish requirements of critical surfaces be designated and therefore closely controlled, but one of the greatest values of a precise designation is the fact that noncritical surfaces can be purposely left rough, this reducing production costs.

Specifically discussed are surface-finish terminology, drawing designation, surface-roughness measurement, surface-roughness comparison, and design criteria. A bibliography, reviewing the work already accomplished in this field, is also included.

Fifteen-Place Tables

FOR many years the extreme difficulty of obtaining high-accuracy tables of sines and cosines with decimal subdivisions of a degree has seriously inconvenienced workers in such fields as observational astronomy, geodesy, navigation, optical-instrument design, ballistics, rocket research, radar, and aircraft design. To meet this need, the National Bureau of Standards has just issued a 95-page booklet of tables of sines and cosines to 15 decimal places at hundreths of a degree.

In the new tables the columns of sines and cosines are arranged side by side for convenience in cases where both the sine and cosine functions are desired for the same argument or where Taylor's theorem is to be used for interpolation. Alongside the tabular entries are presented the second central differences, which are sufficient for interpolation to the full 15 decimal places.

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ASME TECHNICAL DIGEST

Substance in Brief of Papers Presented at ASME Meetings

Petroleum

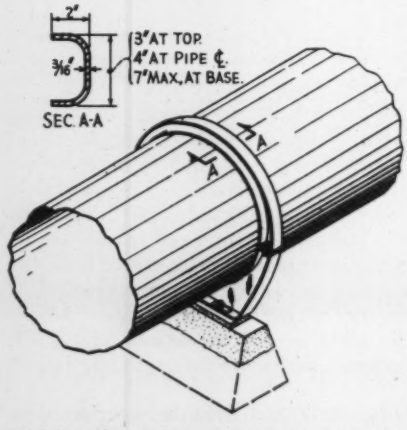
Some Features of the Engineering and Design of the Trans-Arabian Pipe Line, by S. P. Johnson, Standard Oil Company of California, San Francisco, Calif. 1949 ASME Semi-Annual Meeting paper No. 49—SA-23 (mimeographed; to be published in condensed form in the October, 1949, issue of MECHANICAL ENGINEERING).

The principal features of the design of the Trans-Arabian Pipe Line that may be of interest to engineers connected with other large pipe-line projects are outlined. Also, a few of the more interesting and unusual problems of construction are discussed.

The main problem of construction which distinguishes this line from a similar project in the United States is of course the remote location and the large supporting organization that had to be assembled to back up the actual construction staff. A few of the engineering problems, however, are also somewhat unusual.

The Trans-Arabian line was first considered as a probable future venture several years before the war. Serious thought to its immediate construction, however, started in the latter part of 1943 when the U. S. Government considered the construction of such a line as a war measure. At that time the largest pipe available in the United States with suitable properties for pipeline construction was 26 in. OD.

A capacity of 300,000 bpd was tentatively decided on, largely because this is close to the maximum quantity that can be put through 24-in. pipe without excessive pumping costs.



PRESSED-STEEL RING GIRDER SUPPORT FOR 30-IN-DIAM PIPE LINE

The surveyed distance on the present route is 1067.5 statute miles.

When the design of the pipe line was re-examined in 1945, it became clear that the 24-in. pipe was too small for best economy, and that for a nominal average rate of 300,000 bpd (with some allowance for lost time) a thin-wall pipe of approximately 30 in. in diam would be preferable. The pipe as finally selected has been, and still is, being manufactured at Maywood, Calif., from plate rolled at Geneva, Utah. Half the pipe is 30 in. in diam and half 31 in. in diam, and most of it has a nominal wall thickness of $^1/_4$ in. The steel is a medium-carbon, medium-high-manganese material and is semikilled.

The design basis for the pipe line was taken as 65 per cent of the nominal yield point based on nominal thickness, stresses being computed by the conventional outside-diameter or Barlow formula. Such a procedure gives an allowable working pressure of approximately 570 psi for 30-in. pipe having a nominal $^1/_4$-in. wall thickness. When the pipe line was laid out on the basis of a minimum flow of 315,000 bpd (300,000 bbl per average day) and $^1/_4$-in. wall thickness, it was found that at least eight pumping stations would be required, but by increasing the wall thickness of the pipe at the high-pressure part of the line to a maximum of $^7/_{16}$ in., the working pressure could be increased to 885 psi, and by this move it was possible to reduce the number of stations to six.

The maximum elevation on the pipe line is nearly 2900 ft at Milepost 785.

At approximately MP 1032 the right-of-way plunges precipitously into a valley some 13 miles north of Lake Hula, descending to an elevation of 740 ft at MP 1042. The pipe line crosses the north end of the valley proper, although the Jordan River, or Nahr el Hasbani, extends some miles to the north in a narrow and broken canyon. From here the route crosses a spur of hills, reaching an elevation of 1600 ft five miles from the valley floor, and again descends to the Nahr el Litani at MP 1052, elevation 700 ft. This river turns sharply westward and empties into the Mediterranean $8^1/_2$ miles south of Sidon instead of entering the Jordan.

The pipe line again climbs to an elevation of 1700 ft across the southernmost spur of the Lebanese mountains, descending over 1000 ft to the terminal in the last four miles.

The above-ground construction is of principal technical interest. In so far as the supports are concerned, after quite a bit of study of the secondary stresses at supports, it became evident that it would be necessary to reinforce the pipe at these points in some manner, and pressed-steel ring girders were selected as the most economical method of reinforcement, being light, and in large

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quantities, fairly inexpensive. Static bending movements are maximum at the supports, but are only moderate at a 66-ft spacing.

Mechanical Vibration of Piping Induced by Gas-Pressure Pulsations, by Raymond C. Baird and Ira C. Bechtold, The Fluor Corporation, Ltd., Los Angeles, Calif. 1949 ASME Semi-Annual Meeting paper No. 49—SA-27 (mimeographed).

The generation and nature of gas-pressure pulses from reciprocating compressor action is described, together with the propagation of such pulses through pipe lines. This means whereby pulse energy is converted to mechanical vibration is discussed by the aid of analogous mechanical, acoustical, and electrical oscillatory systems. The economic importance of minimizing vibration in compressor and compressor-dependent installations is indicated.

With regard to the manner in which pulsation energy results in mechanical vibration, some of the pulsation energy is converted to periodic physical force because of interaction between the gas and the pipe through which it is flowing. These periodic physical forces, which usually have a complex wave shape, often will contain component frequencies which lie close to or are resonant to the mechanically resonant frequencies of the pipe and/or associated structures. The force stimulation necessary for mechanical vibration is thereby achieved.

Regarding the propagation of pressure pulses through a pipe line, it is believed that technically such cannot be considered as simply the propagation of sound waves in a gaseous medium, even though such a simplification may be entirely within reason for certain engineering applications.

The reason for this lies principally in the following: (1) Pulsation often reaches an appreciable percentage of the average system operating pressure, and (2) there is a requirement for continuous gas displacement or positive unidirectional flow.

Steam Power

Postwar Planning for Steam Capacity in Northern California, by C. C. Whelchel, Mem. ASME, and W. R. Johnson, Pacific Gas and Electric Company, San Francisco, Calif. 1949 ASME Semi-Annual Meeting paper No. 49—SA-10 (mimeographed).

The Pacific Gas and Electric system peak in 1940 was 1,125,000 kw. In December, 1948, it was 2,050,000 kw under daylight-saving time. Standard time would have added 160,000 kw. If the current trends continue it is estimated that the peak in 1951 will be 2,633,000 kw. Planning the required steam-generating capacity to carry its proper share of this unprecedented load growth is discussed in this paper.

The estimated net generation capacity increases, constructed and planned for the 1946–1951 period, include the following:

	STEAM	
1946–47	Two additional units, boilers, and improvements to existing plant in the Eureka area (approx.)	12,000 kw
1948	Kern no. 1	75,000
	Hunters Point	100,000
1949	Hunters Point	100,000
1950	Kern No. 2	100,000
	Moss Landing	100,000
1951	Moss Landing	100,000
	Moss Landing	100,000
	Contra Costa	100,000
	Contra Costa	100,000
	Contra Costa	100,000
	Total steam	987,000 kw
	HYDRO	
1946–47	Pit River No. 1 forebay peaking increase on existing units.	32,000 kw
1948	[a]New Electra	87,000
	West Point	13,000
1949	[a]New Colgate	23,000
	Cresta	68,000
1950	Rock Creek	110,000
	Potter Valley—peaking increase on existing units.	4,000
	Total hydro	337,000 kw

[a] Replaces existing generation totaling about 30,000 kw.

In general, each of the four new steam stations is of semioutdoor design, with the turbine room and control bay entirely housed.

Except for the two 1800-rpm Kern units, where delivery was a prime consideration, the remaining eight main turbine generators involved in this postwar program, each with a nominal rating of 100,000 kw, 15 lb hydrogen, are 3600-rpm machines designed for 1300 psig and 950 F. The turbines are of the tandem-compound double-flow condensing type, and have four extractions to supply steam to the feedwater evaporators and the closed feedwater heaters.

All steam generators included in this program are of the radiant type with tangent waterwall tubes in the furnace.

All of the new steam stations will at times be operated at low loads on standby duty and may then be called on to provide nearly full-load output in a matter of 20 to 30 sec.

Centralized control is a basic feature of the general plant layout of each of the stations, and the operator at the key point in the control room is in position to maintain visual contact with helpers operating the principal items of equipment.

The primary auxiliary power system in each of the stations is 4160 volts, 3-phase. The switchgear used is metal-enclosed with magnetic-type air breakers.

History and Performance of Pacific Gas and Electric Company's Oil Refinery Steam-Electric Generating Stations, by V. F. Estcourt, Mem. ASME, Pacific Gas and Electric Company, San Francisco, Calif. 1949 ASME Semi-Annual Meeting paper No. 49—SA-11 (mimeographed; to be published in Trans. ASME).

Design and operating characteristics are given for the three 1500 psi 940 F steam-electric generating stations built by the Pacific Gas and Electric Company for furnishing process steam and electricity to the three adjacent oil refineries, in addition to generating firm power for its own transmission system. An analysis is made of a number of special problems peculiar to this sort of undertaking, and both the advantages and limitations are discussed and evaluated, with emphasis upon the factors which must be considered in order to gain the maximum benefits from such a joint venture. It is pointed out that this type of plant can deliver the refinery's variable requirements for process steam without materially affecting the ability to generate firm power at high thermal efficiencies. However, high-sulphur fuels require higher exit-gas temperatures in order to avoid air preheater corrosion, with resultant lower boiler efficiencies.

Industrial Power Plant—Weyerhaeuser Timber Company, by Conant Dodge, Jun. ASME, Weyerhaeuser Timber Company, Tacoma, Wash., and Charles W. E. Clarke, Fellow ASME, United Engineers and Constructors Inc., Philadelphia, Pa. 1949 ASME Semi-Annual Meeting paper No. 49—SA-14 (mimeographed).

The need for additional facilities to meet demands for lumber and affiliated products prompted Weyerhaeuser Timber Company to erect a new plant at Springfield, Oreg., on the McKenzie River. As this is a new project, including a sawmill and pulpboard plant, a new power plant was provided to furnish process steam and electric power.

For many years, sawmill refuse and its disposal have been major problems and a large part of the refuse has been used as fuel with little or no consideration given to efficiency. But in the last few years its use in manufacture of pulpboard and

other by-products has increased its value with a resultant necessity for greater efficiency when using it as a boiler fuel.

The new Springfield plant is laid out to take all possible advantage of outdoor construction and the pressure-temperature conditions were set at what was considered logical for the conditions which probably will exist in this mill throughout its useful life.

The power plant is designed primarily for utilization of hogged fuel. Boiler characteristics are 570 psi, 675 F at the superheater outlet. Although this is a comparatively low pressure for central stations or large industrial plants, it is higher than usual for a sawmill power plant; it was adopted on the premise that sawmill refuse in the future, because of newly developed products for its use, would become more valuable and thereby justify operation at the pressure selected.

The plant was designed for a present electric-power load of 12,000 kw and process-steam loads of 95,000 lb per hr at 150 psig, and 100,000 lb per hr at 40 psig. Provision has been made for future expansion by the addition of another boiler and turbogenerator.

The Design of Sewaren Generating Station and No. 1 Unit at Essex Station Public Service Electric and Gas Company, by F. P. Fairchild, Mem. ASME, Public Service Electric and Gas Company, Newark, N. J. 1949 ASME Semi-Annual Meeting paper No. 49—SA-15 (mimeographed; to be published in Trans. ASME).

The more important considerations leading to the design of the 100,000-kw unit at Essex and the four-unit Sewaren Generating Station, are discussed. Outstanding features are semi-outdoor boilers at latitude 41 deg, 1050 F steam temperature, a simplified plant layout including the unit system, central control, shaft-end house generators and all-electric auxiliary drive.

The paper is concerned primarily with the new Sewaren Generating Station, but inasmuch as the Essex 100,000-kw unit was a definite step in the development of many Sewaren innovations and principles, the two may be considered almost as progressive steps in the same program.

The improvements in calculated plant heat rates are shown for the progressive steps of the program.

Some of the more important electrical and architectural features are described.

Essex embodies a considerable advance in the design of 3600-rpm turbines and generators. The turbine was the first 3600-rpm machine to use the 23-in. buckets. These buckets were put through thorough tests in a special test wheel before installation on the spindle.

Forced and induced-draft fans, air preheaters, and flue-dust collectors were placed above the boiler out of doors. For this outdoor service the manufacturers, in co-operation with Public Service engineers, developed fans with air-cooled bearings, large motors of the totally enclosed fan-cooled type, and air-to-oil coolers for hydraulic couplings to eliminate water-cooling connections of any kind. In the interest of simplicity and the reduction of make-up, it was decided to omit the usual auxiliary steam header. This departure involved the development of a motor-driven condenser air-removal pump, a satisfactory substitute for the usual steam-driven auxiliary oil pump of the turbine, the use of air soot blowing, and the elimination of the reserve steam-driven boiler feed pump. Commercial operation of the Essex unit started in December, 1947.

The approach to the basic design of Sewaren was the same as Essex, namely, to develop the unit system to the greatest extent practicable. Here, however, as architectural and structural limitations did not exist, it was possible to accomplish much more in this direction. The Sewaren design makes use of all the features developed for Essex plus two-level operation, semioutdoor boilers, and central control of units in pairs.

The Essex boiler is a two-drum radiant type having a continuous rating of 900,000 lb per hr, and a maximum rating of 1,000,000 lb per hr for four hours with throttle conditions of 1250 and 1000 F.

Each of the first three Sewaren boilers is of the three-drum radiant type, having a continuous rating of 850,000 lb per hr and a maximum of 950,000 lb per hr for four hours with throttle conditions of 1500 psi and 1050 F.

Instruments

Electrical Pick-Offs for Pilotless Aircraft Instruments, by Jack Andersen, Kollsman Instrument Division, Square D Company, Elmhurst, N. Y. 1949 ASME Semi-Annual Meeting paper No. 49—SA-13 (mimeographed).

The advent of pilotless aircraft for military purposes has necessitated the development of a group of special instruments whose function is to provide either a signal for the control of the aircraft, or a signal for use in a telemetering system which radios the information to observers on the ground.

It is the responsibility of the engineer in charge of control and telemetering for a particular pilotless aircraft project to select the most appropriate devices. His choice is influenced by a great number of factors, some over which he has control and others which are a result of the original specification such as, electrical pick-offs. These embody (1) size of aircraft, (2) performance of aircraft, (3) primary and secondary power sources, and (4) system of telemetering (pulse time, frequency-modulated signal on an FM carrier, phase comparison system, etc.). It is the purpose of this paper to aid the engineer in this choice.

The instruments consist basically of two parts: a sensing mechanism and an electrical pick-off which changes the mechanical indication to an electrical signal.

The sensing mechanisms consist of accelerometers, gyros, pressure gages, or thermometers with special characteristics in regard to size, weight, useful life, temperature compensation, and "G" load compensation as required for the particular type of pilotless aircraft.

Gas Turbines

Aircraft Gas-Turbine Installation Considerations, by Benjamin T. Salmon, Consolidated Vultee Aircraft Corporation, San Diego, Calif. 1949 ASME Semi-Annual Meeting paper No. 49—SA-17 (mimeographed).

Aircraft gas turbines may be classified into two broad categories, namely, turboprops and turbojets. This paper discusses several installation considerations governing the application of the different types, within these two broad groups of power plants, to present-day aircraft, based upon actual airplane design and operational experience.

Fundamental installation similarities concern the problems of efficiently gathering and ducting to the compressor inlet great quantities of air of widely varying ambient density and temperature, disposition of equally large masses of high-temperature exhaust gases so as to derive the greatest possible amount of useful work, supply of filtered fuel at high flow rates and moderate pressure, and mounting the engine to provide good accessibility for service without incurring appreciable structural weight penalties.

Installation differences concern the subject of control, propeller and accessory installations, oil cooling, and location of the power plant in the airplane.

Both categories include a number of engine configurations, among which, however, two are more or less basic,

namely, the axial-flow compressor engine and the centrifugal-type compressor engine. To date, work with these configurations has principally concerned itself with open-cycle operation. Augmentation of performance of each by means of water injection or by the addition of tail-pipe burning have proved to be effective for short duration. Other variations presenting interesting possibilities for specific applications are regenerative cycles and ducted fans, the former of principal interest as a means of reducing specific fuel consumption and the latter as a means of also augmenting the low-speed thrust of turbojets. Comparatively little work in these two fields has been accomplished thus far.

Refrigeration

Low-Temperature Cycles and Refrigerants, by David L. Fiske, consulting engineer, New York, N. Y., and Walter F. Jones, Carrier Corporation, New York, N. Y. 1949 ASME Spring Meeting paper No. **49—SA-22** (mimeographed).

Refrigerating equipment for industrial processes below —100 F has been supplied in a limited way for about twenty-five years. The demand was greatly stimulated by the war, which also saw the arrival of more useful and varied equipment, in both machinery and controls, and of new refrigerants as well. Prominent among the new fields of application have been those of ultracold test rooms and laboratories. The refrigerated hangar for testing warplanes at Eglin Field, Fla., produced 950 tons of refrigeration effect at —95 F, with a required horsepower of about 7000, i.e., 7.4 hp per ton. The NACA wind tunnel at Cleveland, Ohio, has a 21,000-hp plant, to provide 7500 tons at a minimum of —67 F, or 2.8 hp per ton. Low-temperature equipment is called for in relation to oil refining, metallurgy, butadiene production, lyophilization, and other applications.

Production of low temperatures down to —150 F is greatly facilitated by modifications in the usual methods of compression refrigeration. Multistaging, either of cascade or of series-intercooler arrangement with refrigerants of the Freon group, offers attractive possibilities in achieving low temperature levels without excessively high or low pressures or sharply reduced capacity in conventional machinery. Data on the new refrigerants Freon-13 and Freon-14, as well as on Freon-22 are presented. Problems of theoretical and actual performance of both reciprocating and centrifugal compressors are explored, particularly that of decreasing capacity with lowered evaporator temperature. The role of air as a refrigerant in the low-level field is re-examined in the light of wartime centrifugal and other equipment developments.

Machine Design

Factors Affecting the Selection and Application of High-Pressure Pumps, Valves, and Fluid Motors, by Herb Vickery, The Rucker Company, Oakland, Calif. 1949 ASME Semi-Annual Meeting paper No. **49—SA-25** (mimeographed).

This paper deals with the problems and factors to be considered in selecting and applying modern high-pressure hydraulic pumps and fluid motors in machine design.

Modern high-pressure pumps, valves, and fluid motors are much more adaptable to present-day machines because of their reduced size, higher efficiency, and generally improved operating characteristics. Their improved design, which permits sustained operation at high pressures, makes them ideal for a wide variety of power applications.

The proper selection of a hydraulic fluid is the first step in fluid-power application. Only highly refined, high-quality, basic crudes are suitable for processing as hydraulic oils. When properly refined and treated with the necessary additives, they become not only the means of transmitting power but also the lubricating and protective agents which insure the proper operation of the hydraulic components.

Careful consideration should be given to proper filtration of the entire hydraulic system.

All hydraulic reservoirs should be provided with a strainer in the filler cap of fine-mesh screen. Suction strainers for the inlet to the pump are available with as low as 0.001-in. slots.

A good pump-operating temperature is from 100 to 125 F, and properly compounded hydraulic fluids will operate well at these temperatures. Where a considerable amount of horsepower is converted to heat, provision must be made for properly dissipating the heat to prevent both the breakdown of the hydraulic fluid and damage to hydraulic equipment. A considerable amount of heat will be dissipated by the tank, piping, and hydraulic units themselves.

On high-pressure hydraulic work, cold-drawn seamless-steel tubing of the proper wall thickness to stand the pressure exerted is the most desirable material for piping. Extraheavy or double-extraheavy pipe is also suitable. A safety factor of 8 is recommended.

Modern high-pressure pumps and fluid motors call for simplicity of design and a minimum of working parts. Not only must the pumps be capable of high volumetric output at high pressures, but the fluid motors must be able to develop high horsepower and high starting, stalling, and running torque to be applicable on many types of drives.

The development and refinement of the dual-vane principle of construction in pumps and fluid motors is a great advance in fluid-power application. In this type of construction each vane slot in the rotor holds a pair of vanes instead of just one vane.

In selecting a fluid motor for a given drive, the requirements should be carefully calculated and the maximum torque required by the drive must be determined. Since torque is proportional to the vane area and the pressure, this will determine the selection of the fluid motor and also the maximum operating pressure of the pump.

In selecting a pumping system for a given application, it must be remembered that the pump must not only be capable of developing the maximum pressure required to produce the desired amount of torque in the fluid motor, but must also be capable of a volumetric output of oil which will produce the required speed in rpm of the fluid motor.

Recent developments in design and construction of axial piston pumps now make available to designers pumps which will operate continuously at a pressure of 5000 psi on hydraulic fluids as thin as AN-VVO-366 aircraft fluid, with volumes as high as 32 gpm. Variable-volume and constant-volume pumps are available and the variable-volume pumps may be provided with any type of pressure or volume control.

The Design of Office Machines Such as Calculators, by Harry T. Avery, Mem. ASME, Marchant Calculating Machine Company, Oakland, Calif. 1949 ASME Semi-Annual Meeting paper No. **49—SA-26** (mimeographed; published in full in this issue, pp. 719-724).

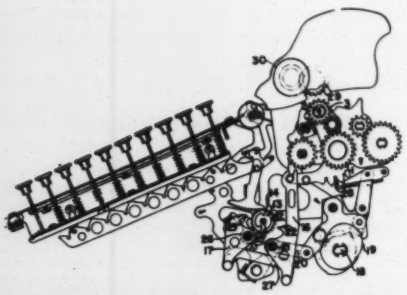
In general, most office machines, including particularly the more automatic types of calculating machines, bookkeeping machines, and the more elaborate types of cash registers, require that a large amount of mechanism for automatically accomplishing a great variety of complicated sequences of operations must be embodied in relatively small space at a minimum of cost consistent with the high accomplishment expected. Particularly in portable machines such

as the desk type of calculators, there seems to be an insistent demand for minimizing the size and weight of a great mass of highly automatic mechanism. This limitation on space to be occupied has a marked effect on resulting design.

The requirement for minimum size and weight requires manufacturing to close tolerances so as to minimize the following: (1) Size of parts, (2) amount of movement required for accomplishing a given function, (3) clearance required between parts, (4) possibility of interference or undesired contact between moving parts on the one hand, and (5) failure of co-operating parts to engage properly and co-operate with each other, on the other hand.

It is most advantageous to plan on producing most of the operating mechanisms of the machines over two basic machine tools, namely, the punch press (for all parts that can be made from flat stock), and the automatic screw machine (for all parts to be made from round stock).

Most of the working flat parts and some of the round parts of most office machines are subjected to heat-treatment. Because of the small size of the parts employed and the type of the loads to which they are ordinarily subjected, high-carbon steel is seldom used, but a steel with about 0.10 per cent carbon is subjected to a treatment which will leave a soft tough core but provide a thin extremely hard case, usually 0.001 to 0.004 in. thick. For most of the parts of a calculating machine, or similar piece of office equipment, this is accomplished by immersion in sodium cyanide at about 1500 F, and quenching in oil.



RIGHT-SIDE VIEW OF A KEY SECTION, AUTOMATIC GEAR SHIFT, AND TRANSMISSION UNIT OF A CALCULATING MACHINE

The methods and techniques employed in the design of such machines from first disclosures through to final release for tooling and production, are presented. An illustrative design of a portion of a calculating machine setting forth the objectives of the design and a description of the design finally adopted for attaining these objectives, is given.

Human Engineering

The Human Factors in the Design of Manual Machine Controls, by Louis E. Davis, Jun. ASME, University of California, Berkeley, Calif. 1949 ASME Semi-Annual Meeting paper No. **49—SA-30** (mimeographed; to be published in full in the October, 1949, issue of MECHANICAL ENGINEERING).

One of the industrial engineer's primary areas of interest is man at work; the work methods he uses, the tools and equipment he uses, the conditions under which he works, his motivation to work, the monotony and fatigue effects of the job, and his part in the social complex of the work situation. This catholic interest has led to many and varied investigations into the factors affecting the work situation. A great deal of attention has been devoted to investigating methods of work and to formulating general principles governing the development of effective working methods. The engineer has probably devoted the greatest amount of attention to this area.

An important factor influencing methods of work is the design of tools, equipment, and machinery provided for the job. With the advanced state of design of machine tools today, it is incongruous to find that many machines are ill-suited to the people who operate them, and are thus the direct cause for ineffective working methods. During the recent war, the armed services found that many of their critical devices, while mechanically perfect, were incapable of effective operation by highly skilled individuals. Detailed investigations by industrial psychologists and engineers indicated that the "human factors" in the design and operation of the equipment were overlooked.

Understanding these factors means having a knowledge of the relationship between the worker and the machine he operates. To provide information concerning this relationship, a series of studies are currently in progress at the University of California.

This paper describes an experimental study which was undertaken to determine the factors making for optimum control and speed of usage of handwheels, cranks, and crossbars under the conditions of application involving single settings of indicators within close tolerance limits. A work station was designed and subjects trained to perform the simple operation of setting the indicator by means of the control devices. The variables introduced were different frictional torques on the control shaft, different locations of the control devices, and different types and sizes of control devices. The results indicate that for each control location there appears to be a correlation between work load on the control shaft and the size of control device for optimum performance.

ASME Transactions for August, 1949

THE August, 1949, issue of the Transactions of the ASME contains the following:

Hot-Spin Tests of Bladed Jet-Engine Rotors, H. B. Saldin and P. G. De Huff, Jr. (48—A-121)

Comparison of High-Temperature Alloys Tested as Blades in a Type B Turbosupercharger, W. C. Stewart and H. C. Ellinghausen (48—A-96)

The Applicability of Ceramics and Ceramals as Turbine-Blade Materials for the Newer Aircraft Power Plants, A. R. Bobrowsky (48—A-135)

Changes in Internal Damping of Gas-Turbine Materials Due to Continuous Vibration, G. B. Wilkes, Jr. (48—A-95)

The Mechanical Seal—Its Construction, Application, and Utility, C. E. Schmitz (48—A-70)

Cyclic Heating Test of Main Steam Piping Joints Between Ferritic and Austenitic Steels—Sewaren Generating Station, H. Weisberg (48—A-87)

Energy in the Engine Exhaust, P. H. Schweitzer and T. C. Tsu (48—A-56)

Symposium on the Reheat Cycle:

Operating Experiences in Connection With Regenerative Reheat-Turbine Installations, C. A. Robertson (48—A-91)

Developments in Resuperheating in Steam Power Plants, E. E. Harris and A. O. White (48—A-125)

Steam Turbines for Resuperheat Cycle, E. E. Parker (48—A-58)

Reheating in Steam Turbines, R. L. Reynolds (48—A-141)

Steam-Generating Equipment for Resuperheating Cycles, Martin Frisch (48—A-120)

High-Pressure Boilers With Reheaters, W. H. Rowand, A. E. Raynor, and F. X. Gilg (48—A-60)

Modern Reheat Boilers, W. S. Patterson (48—A-106)

Discussion on Seven Preceding Papers

COMMENTS ON PAPERS

Including Letters From Readers on Miscellaneous Subjects

Hydrodynamic Oil Films

COMMENT BY JOHN BOYD[1]

Mr. Roach has discussed a subject[2] which, although it may not have great theoretical interest, is extremely important in establishing the proper design for a bearing to be used in a given application, and he has emphasized the limitations of present theories in fulfilling the practical needs of the bearing designer.

With regard to the criterion of film stability, the usual explanation, as described in connection with Fig. 1 of the paper, has always seemed rather unsatisfactory to the writer. For example, when we say that to the right of the minimum point an "increase in friction coefficient due to an increase in load will be self-compensating, since the increase in temperature due to the higher friction coefficient tends to reduce the viscosity of the lubricant, which in turn tends to reduce the friction coefficient to its original value," we neglect the experimental fact that, to the right of the minimum point, an increase in load results in a decrease in friction coefficient as is shown by the curve.

By themselves, neither the friction coefficient nor the Sommerfeld number appears to be important in determining load-carrying ability. They only have meaning when considered in connection with the other factors which are involved. An important consideration is the heat which is developed.

To the right of the minimum point, the experimental relation between the friction coefficient and $\frac{\mu N}{p}$ can be expressed approximately by the relation

$$f = \frac{K_1 \mu N}{p}$$

where K_1 is a constant. The frictional work H is proportional to $f \times p \times N$, hence

$$H \approx K_1 \mu N^2$$

Assuming that the oil flow Q through the bearing is proportional to the speed, which is the case in many bearings, we may write

$$Q \approx K_2 N$$

Since the frictional work raises the temperature of the oil, the temperature rise ΔT, may be written

$$\Delta T \approx \frac{K_1 \mu N^2}{K_2 N} \quad \text{or} \quad \Delta T \approx K_3 \mu N \ldots [1]$$

To the left of the minimum point, the curve is approximately hyperbolic and f may be expressed

$$f = \frac{K_4 p}{\mu N}$$

Solving for the temperature rise as before

$$\Delta T \approx \frac{K_4 P^2}{K_2 \mu N} \quad \text{or} \quad \Delta T \approx \frac{K_5 P^2}{\mu N} \ldots [2]$$

Equations [1] and [2] of this comment illustrate the difference between conditions to the right and the left of the minimum point. Thus Equation [1] indicates that increasing or decreasing the load does not affect the temperature rise. If the speed is raised, the resulting increase in temperature acts to decrease the viscosity, and hence to lessen the effect of increased speed.

To the left of the minimum point, the temperature rise increases with the square of the load. It also increases if the speed is reduced. Since increased temperature lowers the viscosity, the temperature rise is further increased.

Although Equation [2] shows that changes in load and speed are apt to produce a greater effect to the left of the minimum point than to the right, it does not indicate, as is often assumed, that a bearing operating in the left region is unstable in that it is doomed to certain failure. If thermal equilibrium can be established before the bearing or the lubricant is damaged, satisfactory operation can be obtained. Many of the water-lubricated stern-tube propeller-shaft bearings for ships operate throughout their entire life in this region and give entirely satisfactory service.

COMMENT BY D. D. FULLER[3]

The author is to be congratulated for summarizing in a concise manner the present state of knowledge, or lack of knowledge, regarding the hydrodynamic theory of lubrication. Perhaps his emphasis upon what is not known, as compared to what is known, would produce a somewhat misleading impression upon one who is a complete stranger to the subject. In all fairness we should say that, at least for static loads on journal bearings, it is possible to get fair agreement between predicted and experimental results. Many will agree it is possible to predict with sufficient accuracy minimum oil-film thicknesses, which of course involves leveling off temperatures of the bearing and dissipation of energy in friction and heat.

There is no question that much is yet to be learned regarding the design of journal bearings, especially for the state of dynamic loads, and the author has certainly done a service in re-emphasizing that lack of knowledge. One aspect of his analysis, regarding the variables of journal-bearing performance, will be discussed by the writer. The particular variable in question has to do with the influence of pressure on viscosity.

The author states that the increase in viscosity with increase in pressure is of somewhat less interest from a practical viewpoint than some of the other variables. He continues that this effect does not become appreciable at pressures in the range of current bearing loading practice, and shows in his Fig. 3, that the range of present-day bearing loads reaches 8000 psi. It is true that the average bearing pressure, based upon projected area, is found within this range, but the maximum pressure in the oil film actually can be many times higher than the average pressure. As a consequence, it may be that the increase in viscosity due to pressure may have a considerable effect on the load-carrying capacity.

One of the earliest references to this phenomenon is by T. E. Stanton.[4] Figs. 1 and 2 of this discussion are reproduced

[1] Westinghouse Research Laboratories, East Pittsburgh, Pa.

[2] "The Load Carrying Ability of Hydrodynamic Oil Films," by A. E. Roach, MECHANICAL ENGINEERING, vol. 71, April, 1949, pp. 293–296 and 326.

[3] Associate Professor, Department of Mechanical Engineering, Columbia University, New York, N. Y. Jun. ASME.

[4] "Friction," by T. E. Stanton, Longmans, Green and Company, New York, N. Y., 1923.

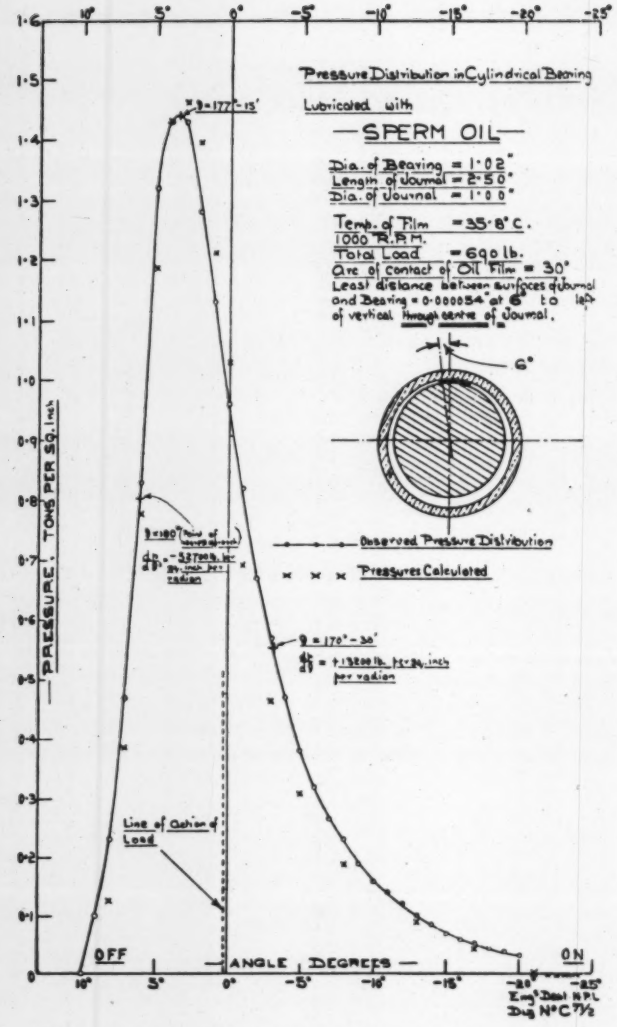

Pressure Distribution in Cylindrical Bearing
Lubricated with
—SPERM OIL—
Dia. of Bearing = 1·02"
Length of Journal = 2·50"
Dia. of Journal = 1·00"
Temp. of Film = 35·8° C.
1000 R.P.M.
Total Load = 690 lb.
Arc of contact of Oil Film = 30°
Least distance between surfaces of Journal and Bearing = 0·000034" at 6° to left of vertical through centre of Journal.
Observed Pressure Distribution
Pressures Calculated
Line of action of Load
OFF
ANGLE DEGREES
ON
PRESSURE, TONS PER SQ. Inch

FIG. 1 PRESSURE DISTRIBUTION IN CYLINDRICAL BEARING LUBRICATED WITH SPERM OIL

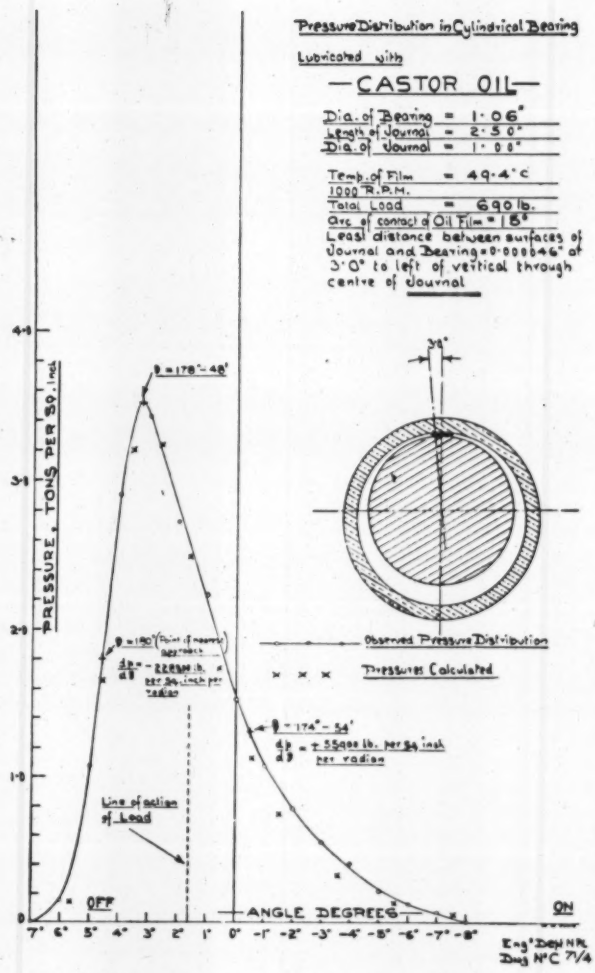

Pressure Distribution in Cylindrical Bearing
Lubricated with
—CASTOR OIL—
Dia. of Bearing = 1·06"
Length of Journal = 2·50"
Dia. of Journal = 1·00"
Temp. of Film = 49·4° C
1000 R.P.M.
Total Load = 690 lb.
Arc of contact of Oil Film = 15°
Least distance between surfaces of Journal and Bearing = 0·000846" at 3·0° to left of vertical through centre of Journal
Observed Pressure Distribution
Pressures Calculated
Line of action of Load
OFF
ANGLE DEGREES
ON
PRESSURE, TONS PER SQ. Inch

FIG. 2 PRESSURE DISTRIBUTION IN CYLINDRICAL BEARING LUBRICATED WITH CASTOR OIL

from his text, and they show the results of pressure measurements in a 360-deg journal bearing while in operation. These bearings were set up with large clearances so as to produce severe operating conditions. The diameter of the bearing, Fig. 1, is 1.02 in.; diameter of journal, 1.00 in., length of journal, 2.50 in. The pressure traverse was obtained during actual operation of the bearing by means of a pressure gage connected through a tapped hole in the bearing. The bearing itself was rotated, and the pressure traverse obtained as shown in the diagram. Notice that with a total load of 690 lb, acting, or an average pressure based upon projected area of 276 psi, a maximum pressure was obtained in the load-carrying film of 3170 psi. The ratio of the maximum pressure to the average pressure was 11.5 to 1.

In Fig. 2, herewith, the same bearing with a larger clearance shows a maximum pressure in the load-carrying film of 7700 psi. Again the average pressure was 276 psi, making the ratio of maximum pressure to average pressure of almost 28 to 1. Now these are not normal conditions of bearing operation, but nevertheless the pressure ratios serve to emphasize the phenomenon that does take place. Notice also that, in spite of these being complete bearings, the pressure-carrying arc does not extend 180 deg along the circumference.

In Fig. 1, the actual load-carrying arc was only 30 deg in length. In Fig. 2 the arc of actual load-carrying film was reduced to 15 deg. It seems that the more severe the loading of the bearing, the greater is the eccentricity of the shaft or journal in the bearing, and the shorter the length of the actual load-carrying arc. E. M. Barber and C. C. Davenport[5] have given similar pressure-distribution curves which were obtained in much the same manner.

Fig. 3 of this discussion shows a sampling of four of these curves. They are identified as Nos. 7-5, 7-6, 7-7, and 7-8. The average pressures for these tests were somewhat low, as compared to current journal-bearing design practice. Test No. 7-5 was run at a pressure of 105 psi, increasing to 244 psi for test No. 7-8. As the diagrams indicate, the ratio of maximum pressure in the film to an average pressure ranges from 2.05 to 1 for test No. 7-5, up to 2.77 to 1 for test No. 7-8.

In a previous paper,[6] John Goodman, again shows several pressure-distribution

[5] "Investigation of Journal Bearing Performance," by E. M. Barber and C. C. Davenport, The Pennsylvania State College, Bulletin no. 42, 1933.

[6] "An Experimental Determination of the Distribution and Thickness of the Oil Film in a Flooded Cylindrical Bearing," by John Goodman, part 2, Proceedings of The Institution of Civil Engineers, vol. 233, 1931-1932, 25 pp.

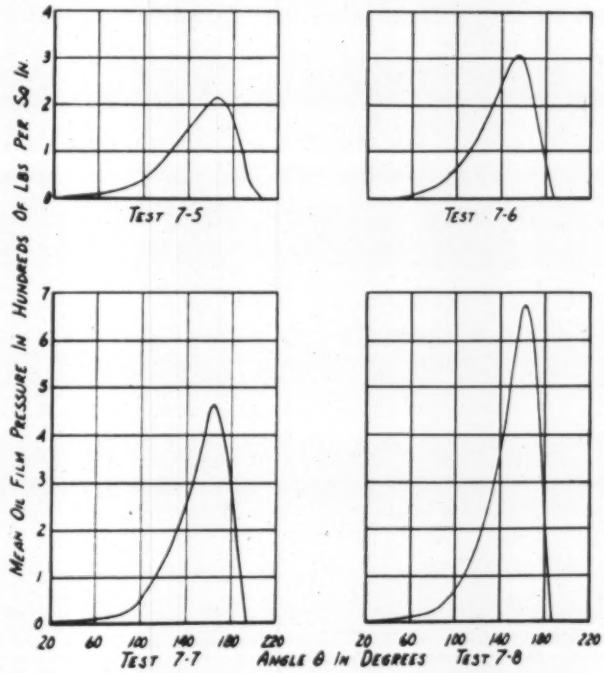


FIG. 3 MEAN PRESSURE CURVES; BEARING NO. 7, 1600 RPM, OIL NO. 1

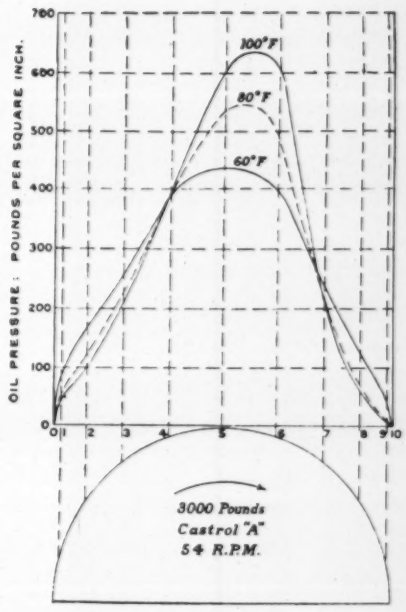


FIG. 4

curves. Fig. 4, herewith, is such a curve. The bearing was 6 in. diam, with a 3-in. length; diametral clearance 0.0038 in. This was a 180-deg, partial bearing. The average pressure, based upon projected area, was 167 psi. Fig. 4 shows that the maximum pressure in the oil film reached 650 psi, a ratio of maximum pressure to average pressure of approximately 4 to 1.

Referring to a paper by S. A. McKee and T. R. McKee,[7] we find the results of a similar study. Fig. 5 is reproduced from this paper, showing that the maximum pressure observed in the film is considerably higher than the average pressure. The McKees' report for these bearings, which were very lightly loaded (only 29 psi), that the maximum pressure varied from $2^1/_2$ to 4 times the average pressure, based upon projected area.

Journal bearings in practice, operate with loads that are not nearly as light as the bearing tests which have just been reported. For actual bearings running under fairly severe conditions of operation, we might assume that the maximum pressure in the oil film may be of the order of magnitude of 10 times the average pressure, based upon projected area. In such a case, taking a numerical example, if the average pressure is 1000 psi, the maximum pressure in the oil film may be 10,000 psi.

Referring to a paper by Hersey and Hopkins,[8] we find that, for a typical SAE 30 motor oil, the increase in viscosity at 10,000 psi over the viscosity, at ambient atmospheric pressure would be a factor of 9. Where the average pressures are higher than 1000 psi, it seems reasonable to expect that maximum film pressures may reach an order of magnitude of 20,000 psi. At such a pressure most lubricants become plastic solids, and, thus, the increase in viscosity would be quite considerable.

These facts are being brought to the attention of the author, for it may very well be that the increase in viscosity due to pressure may be a greater contributing factor to the performance and operating characteristics of journal bearings than he has indicated in the paper.

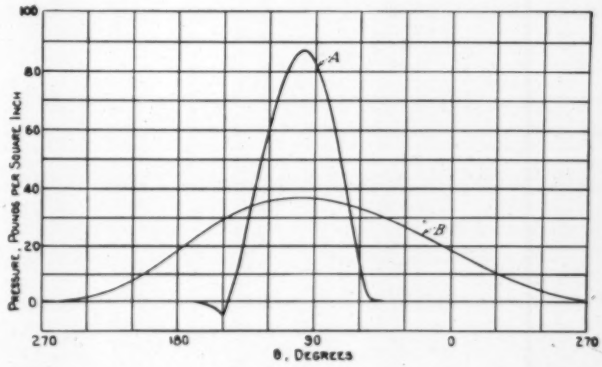


FIG. 5 COMPARISON OF EXPERIMENTAL AND CALCULATED DISTRIBUTION

(Curve *A*, circumferential distribution at center of bearing, test no. 6; curve *B*, circumferential distribution computed from hydrodynamical equations for same bearing under same operating conditions, but with no end leakage.)

COMMENT BY MILTON C. SHAW[9]

In research in many fields, new ideas frequently arise from a reconsideration of the basic assumptions on which old theory is based. In the present paper, the author has considered a few of the many variables which are not covered adequately by the simplest lubrication theory. While it is not possible to cover all aspects of as complicated a problem

[7] "Pressure Distribution in Oil Films of Journal Bearings," by S. A. McKee and T. R. McKee, Trans. ASME, vol. 54, 1932, RP-54-8, pp. 149–161.

[8] "Viscosity of Lubricants Under High Pressure," by Mayo D. Hersey and R. F. Hopkins, MECHANICAL ENGINEERING, vol. 67, 1945, pp. 820–824.

[9] Department of Mechanical Engineering, Massachusetts Institute of Technology, Cambridge, Mass. Mem. ASME.

as the lubrication of a full journal bearing in the limited space available, the circumferential extent of the oil film should be included in the list of variables affecting the load-carrying capacity. The simpler engineering computations of bearing-load capacity either do not treat this important variable satisfactorily or omit it altogether. The circumferential extent of the oil film is generally far more important than the variation of viscosity with temperature. In this connection we might question the author's statement that the reduction of viscosity with increase in temperature results in an appreciable loss of load-carrying capacity. This problem has been studied by a number of investigators and the consensus of opinion is in agreement with the statement in the author's reference (41), to the effect that the variation of viscosity with temperature influences the load capacity of a journal bearing about but 5 per cent—an amount which is well within the agreement to be expected between any lubrication calculation and experiment.

The author's mention of certain special problems which are apt to be encountered at very high speeds brings to mind the fact that all present bearing theory is based upon an assumed condition of laminar flow. Just as a critical Reynolds number exists for flow in a straight pipe it is to be expected that a similar critical Reynolds number exists for flow in the curved clearance space of a bearing. Considerable attention has been given the question of flow stability in the fluid between two rotating coaxial cylinders as an abstract problem of fluid mechanics.

Taylor[10,11] has studied this problem extensively both analytically and experimentally, employing clearances that are large in comparison with those used in journal bearings. The critical speed of rotation was found to be less with the inner cylinder in motion and the outer cylinder at rest than when the outer cylinder was rotated and the inner cylinder was at rest. The difference between these two values of critical speed was found to decrease rapidly as the clearance-diameter ratio was decreased. For example, the ratio of the two critical speeds was approximately 50 for a clearance-diameter ratio of 0.1, 6 for a clearance-diameter ratio of 0.017 and by extrapolation the two critical speeds were estimated to be the same when the clearance-diameter ratio was in the neighborhood of 0.001. Thus it is evident that the critical speed for a journal bearing should be essentially the same regardless of whether the journal or bearing surfaces are in motion.

When the clearance-diameter ratio is of the order of 0.001, the curvature of the bearing surface is negligible and the problem can be considered the same as though there were flow between plane parallel plates. By extrapolating Taylor's experimental results in the direction of decreasing film thickness, the condition for stable flow between parallel plates is found to be

$$\frac{Uc}{\nu} < 2000$$

where U is the linear velocity of one of the plates, c is the radial clearance, and ν is the kinematic viscosity of the fluid. Any convenient system of units that is consistent may be used, inasmuch as Reynolds number is dimensionless.

A high-speed bearing having the following representative dimensions will be considered in order to determine the likelihood of turbulence developing in the oil film:

Diameter	2 in.
Diametral clearance	0.004 in.
Density of oil	83.3×10^{-6} lb sec^2/in.^{4}
Viscosity of oil	0.5×10^{-6} Reyn.

The critical speed for this bearing is found to be 57,000 rpm. This is a very high rotative speed for a 2-in-diameter bearing, and it would appear that there is little chance of turbulence developing in the oil film of such a bearing having conventional clearance when operating with an ordinary hydrocarbon lubricant. However, should this bearing operate with a relatively large clearance and a lubricant of very low viscosity, turbulence might develop in the oil film at a speed that is well within the practical operating range. For example, if the diametral clearance of the foregoing bearing were increased to 0.006 in. and the kinematic viscosity reduced from 6×10^{-3} to 10^{-3} sq in. per sec, the critical speed would be reduced to 6360 rpm. Thus, while the possibility of turbulence developing in the oil film of a journal bearing, operating at a low or moderate speed, seems rather remote, it appears that the critical Reynolds number for a journal bearing might be exceeded in certain large units operating at high rotative speeds.

COMMENT BY BURT L. NEWKIRK[12]

The author has produced a clear and helpful résumé of the known facts in this field. The writer wishes to comment on the matter of oil-film whirl. Fig. 6 of the paper is a reproduction of one that appeared in reference (28) to show the behavior of our model X11A when set up with the shaft vertical. A ball bearing at the upper end of the shaft carried the weight of the rotor. The "oil resonance" at about 1500 rpm, and "whipping" above 2250 rpm were ascribed to oil-film action, modified perhaps by some damping action in the upper bearing. This model when set up with the shaft horizontal did not show the feature of quiet running above the oil-film resonance, neither did any of the other models which ran with the shaft horizontal. In all cases, except the one represented in the figure, the whirling occurred at all speeds above that at which it started, which was, broadly speaking, about twice critical speed. It is true, however, that the stimulus is usually weak at the lower speeds and increases with increasing speed.

In our first paper (author's reference 28) on the oil-film whirl, we offered an explanation summarized by the author in the paragraphs following the figure. In order to account for the maintenance of the whirl at speeds above twice critical, we had to assume that at these higher speeds leakage of the oil increased progressively with increasing speed, because the whirl frequency remained constant.

In subsequent studies it apeared that the oil-film whirl did not start exactly at twice critical speed but at various speeds for various conditions of bearing loading, bearing length, and the like. The whirling started in some cases at speeds well below twice critical speed. In other cases, operation remained stable up to speeds well above twice critical speed. In all cases, the whirling, when it did occur, was at a whirl frequency which was nearly the frequency of the shaft for free transverse vibration; the same numerically as the critical speed.

In the light of many such observations, we began to feel that the oil-film resonance plays a minor role in the oil-film whirl, and that the true explanation may lie in an instability characteristic of the oil film. With very heavy unit loads, the range of stable operation extended in most cases well above twice critical speed. We thought the success of the "nonwhirling bearing"[13] was due to the fact that the journal ran low in the bearing where the film might be more stable. From this point of view it appears that the various discussions, which have been

[10] "Stability of a Viscous Liquid Contained Between Two Rotating Cylinders," by G. I. Taylor, Trans. Royal Society, vol. A-223, 1923, p. 289.

[11] "Fluid Friction Between Rotating Cylinders," by G. I. Taylor, Proceedings of the Royal Society, vol. A-157, 1936, p. 546.

[12] Professor, Vibration Theory and Practice, Rensselaer Polytechnic Institute, Troy, N. Y. Mem. ASME.

[13] "Oil-Film Whirl—A Nonwhirling Bearing," by B. L. Newkirk and L. P. Grobel, Trans. ASME, vol. 56, 1934, pp. 607–615.

published recently, explaining the oil-film resonance on the basis of hydrodynamic theory, do not explain the oil-film whirl as it occurs at speeds far above twice critical speed. The oil film resonance is a whirl, at critical-speed frequency, when the rotor is running at twice critical speed.

AUTHOR'S CLOSURE

The author agrees with Mr. Boyd's comment regarding the need for caution in using $\mu N/p$ as a criterion for the load-carrying ability of a bearing. The particular usefulness of $\mu N/p$ lies in its functional relationship to other variables of interest; for example, friction coefficient f and relative film thickness h_m/c. For similar bearings (denoted by subscripts 1 and 2), dimensional considerations indicate that when $(\mu N/p)_1 = (\mu N/p)_2$, then $f_1 = f_2$ and $(h_m/c)_1 = (h_m/c)_2$. Hence $\mu N/p$ is a valid criterion for the "safeness" of bearing operation only in so far as particular values of f and h_m/c have been found safe for similar bearings. As Mr. Boyd correctly points out, thermal conditions must be considered. Thus, in order that bearings 1 and 2 shall be comparable on a $\mu N/p$ basis, they must not only be geometrically similar but they must also be thermally similar, viz., they must be constructed of and housed in materials of the same thermal conductivities, they must have similar oil-flow rates with oils of the same specific heat, they must operate in similar thermal environments, and so forth.

Professor Fuller has presented a concise summary of some experimental data on oil-film pressures in bearings. While the effect of pressure on the viscosity of the oil film is important, it must, however, be considered in conjunction with the effect of temperature. As suggested by Fig. 3 of the paper, it is the latter effect which appears to predominate in many cases of practical interest.

Professor Shaw's comment regarding the character of the flow in a bearing is of considerable interest. The question was considered briefly by Reynolds,[14] and, apparently, it has not been necessary to re-examine his conclusions since that time, inasmuch as our work has been concerned almost exclusively with fairly small clearances, moderate speeds, and fairly viscous lubricants—all of which have assured low Reynolds numbers and laminar flow. Equally important, our problems have been largely the problems of heavily loaded bearings in which the load-supporting portion of the film has been quite convergent; this convergence has a powerful stabilizing effect on the flow of this portion of the oil film.

Recent developments in machines requiring lightly loaded high-speed bearings may, however, change this situation. In oil-film bearings for aircraft gas turbines, for example, the bearings are fairly large, the speeds are high, and the high rates of shear compel the use of lower-viscosity lubricants—all of which mean higher Reynolds numbers and a closer approach to turbulence. Equally important, gas-turbine bearings normally support only the static weight of the relatively light rotating parts and are subjected to large dynamic forces only momentarily during maneuvers. These light loads coupled with high speeds mean that the journal runs more nearly concentric in the bearing, and so we lose the stabilizing effect of pronounced convergence of the oil film.

These considerations give added importance to Professor Shaw's comment and point to the need for further examination of the theory and for new experimental studies of these phenomena.

ARVID E. ROACH.[15]

[14] See Author's Bibliography (1) section I.

[15] Research Laboratories Division, General Motors Corporation, Detroit, Mich.

The Recent College Graduate in the Field of Machine Design

COMMENT BY A. H. CHURCH[16]

Professor Young has given a clear picture of what industry can expect of recent college graduates in the machine-design field,[17] and should be highly commended for this effort. While his remarks are directed to the subject of machine design, they apply equally well to all branches of engineering.

Recently at New York University, we have revised our mechanical-engineering curriculum. In the process, we analyzed the current curricula of a number of other colleges. While there were some marked minor differences, there was also a decided consistency in them. The typical current curriculum may be summarized as shown in Table 1 of this comment, which is divided into general groups. This table should be of interest to those hiring recent graduates, since it indicates where the emphasis is placed in their training, and hence one may realize from it why the young graduate is as the author has described him.

Roughly 20 per cent of his time is spent on cultural subjects, 25 per cent on pure mathematics and science, and about 50 per cent on engineering specialties and their applications. This latter group is further broken down into "machine design," "heat power," and "general." It may be noted that roughly one half of this engineering group, or 25 per cent of the course is devoted to machine design or directly allied topics. Since machine design is such a broad subject, it might well be argued that the items listed under "general" should be included under machine design. This would raise that percentage still more. In any event, machine designers have little cause for complaint regarding the amount of time devoted to their field.

To emphasize the point which the author made, regarding the fact that the colleges cannot teach experience, we constantly strive to do this, but generally without success, because of the shortage of time and the breadth of the field. About all that the colleges can hope to do is to emphasize the fundamentals.

TABLE 1 TYPICAL CURRENT MECHANICAL ENGINEERING CURRICULUM

	Credits	Per cent
Humanities:		
English and speech	9	6
Economics	6	4
General	16	10.6
	31	20.6
Mathematics and Science:		
Chemistry	10	6.7
Mathematics	16	10.6
Physics	14	9.4
	40	26.7
Machine Design:		
Drawing and descriptive geometry	6	4.0
Mechanics	7	4.7
Shop practice	4	2.7
Metallurgy	4	2.7
Strength of materials	8	5.3
Kinematics and machine design	8	5.3
	37	24.7
Heat Power:		
Thermodynamics	8	5.3
Heat power	9	6.0
	17	11.3
General:		
Fluid mechanics	5	3.3
Electrical engineering	9	6.0
Miscellaneous (thesis, surveying, electives)	3	2.0
	17	11.3
Military science or physical education	8	5.3
Totals	150	99.9

[16] Professor of Mechanical Engineering, New York University, College of Engineering, New York, N. Y. Mem. ASME.

[17] "What Can the Machine-Design Field Expect From the Recent College Graduate?" by C. H. Young, MECHANICAL ENGINEERING, vol. 71, April, 1949, pp. 297–298.

The experience and special techniques must be developed by the individual company during the early years of the graduate's association with it.

COMMENT BY J. B. HARTMAN[18]

The author has presented a comprehensive description of the college graduate entering the machine-design field. Of particular interest are his remarks relating to the employer's responsibility in training young engineers for advancement. It is well recognized that many graduates of promise avoid the field of design because of a fear of being tied down to a drawing board. The prospective employer should present a true picture of the opportunities available for growth and individual creative work. Avoid drudgery. Let the man feel that his tasks require a college education. A recent survey made by the writer, covering 100 representative industrial plants in 23 states indicated that less than 50 per cent followed a specific training procedure for young designers.

Professor Young emphasizes learning "to appreciate the practical application of the things he (the graduate) learned in college." It must be kept in mind that emphasis in college is, of necessity, on "fundamentals." These fundamentals are presented in separate "containers" called "courses." The contents of these "containers" need to be correlated and co-ordinated in practical applications. A proper choice of early assignments will aid greatly the necessary transition. Let the man follow through completely on the various steps of a problem which has previously been solved successfully, to become acquainted with procedures.

COMMENT BY A. W. LUCE[19]

Professor Young has given a good summary of the qualifications of the college graduate but the writer would like to emphasize a few points.

We continue to organize our undergraduate curricula in terms of the art of engineering as "civil," "mechanical," and the like. In the 71 years of this Society's existence, does it not seem possible that a major change in education should have appeared? Actually, our graduate has selected a field of study—probably more through his emotions than knowledge—and at graduation finds that his decision is not one between civil or mechanical engineering, but between research or sales, design or production, and that the electrical and mechanical engineering graduates have the same decision to make. Actually, the training of graduates in all these branches has not been directed specifically toward that decision.

The writer is suggesting that we should be considering a revision of instruction, minimizing the influence of Founder Society names on course material, and giving more attention to the nature of the work the individual will do. There is little fundamental difference between the production problems of laying so many yards of concrete highway per month, mining tons of coal, producing automobiles, or in our field of machine design, producings drawings according to schedule. Designing is a challenging and satisfying profession for the man who likes it regardless of the particular engineering field.

We could train better designers if we made the kind of work, rather than the branch of engineering, the basis of specialization. The degree of specialization should be no more exclusive than it is now, but account would be taken of the fact that the junior student would not know just what his job would be when he graduated. We still must give him an engineering education.

About the most important factor in the life of the new graduate is his immediate boss. He has more to do with the success of our graduate in the employ of a given company than do either the college or the graduate himself. Unfortunately, the recruiting officer from the personnel department cannot tell the graduate much about his future boss. The same thing applies in the colleges. Whether or not the course is good depends upon the instructor more than upon the physical plant or top-level educational policy.

The graduate's supervisor has an educational opportunity far exceeding that of the college. Every week he will have the graduate as many hours as we did in a single credit hour of laboratory.

COMMENT BY B. P. GRAVES[20]

The writer is greatly interested in the author's outline of the so-called technological stem or the engineering part of the student's education. It is noted that the author emphasizes to some extent "teaching the fundamental principles." In a paper by the writer,[21] the thought was stressed of teaching students the fundamental principles of engineering, feeling that it is the most important factor. A student well grounded in fundamentals when entering industry, will have a firm foundation from which to work.

In the present paper the author further states, "We now have a well-rounded graduate who has been taught to define his problem, to assemble and analyze the data, and to devise a satisfactory method of solution...." The writer does not deny all this but to his mind there is something lacking as we find in our work with the new graduate students that they seem to be unable to recognize a problem simply because it is surrounded with a practical atmosphere. Invariably we have taken the young man in hand and outlined one of his problems which he has had in school and then referred him to the problem under consideration, outlining to him the similarity—he then begins to recognize the problem before him.

It seems to the writer that something could be added to the student's teaching so that he will have a little better knowledge of what he is to face in industry. In order to help this situation, in the Providence area, we have started an extension course at Brown University where drafting-room apprentices, graduate apprentices, and graduate engineering students are being taught practical problems in the fundamentals of engineering. This class is being taught by two of the writer's engineers. All the problems in this course are taken from everyday practice in the designing of machine tools. To show how much this is appreciated, we have a class of 73 students, whereas our original estimate, although set as we thought rather high, figured about 40. The thought is that if similar problems could be put to the student near the end of his course, it would help him materially when entering industry.

The last portion of this paper also has created some interest to the writer, since the author has outlined to a considerable extent what we cannot expect to find in this young man; and certainly industry does not expect to find in him a machine designer. We do, however, expect to find a young man who will recognize his shortcomings, and who will be patient when we try to instruct him along this line. Another point that strikes a rather forceful note is where the author states, "we won't even get a good draftsman." This is certainly true; many of the drawings made by a young college graduate fall into about the same class as a student's handwriting. But the thing that concerns the writer greatly—and this is the situation that we seem to

[18] Associate Professor of Mechanical Engineering, Department of Mechanical Engineering, Lehigh University, Bethlehem, Pa. Mem. ASME.

[19] Head of Department, Chairman of Curriculum in Mechanical Engineering, Pratt Institute, Brooklyn, N. Y. Mem. ASME.

[20] Director of Design, Brown & Sharpe Manufacturing Company, Providence, R. I. Fellow ASME.

[21] "A Machine Tool Designer's Thoughts on Engineering Education," by B. P. Graves, Proceedings of the American Society for Engineering Education, vol. 55, 1947–1948, pp. 211–217.

run across a great deal—is the impatience on the part of the student because he feels he should not have to spend time on the drawing board. We in industry feel that unless a man can make a good drawing we cannot expect too much from him in the design group where it will certainly be necessary for him to make a good readable layout. The author states that industry expects too much from a young student—that when the boy is going through school his passing marks run from 65 to 70 per cent which is an accepted grade, and when the student achieves a B or better he struts with pride.

The author goes on to point out that in industry 100 per cent is the passing grade and that this naturally worries the young man. The writer would like to correct this particular concept, because we in industry do not expect 100 per cent. We cannot even achieve this high percentage with our mature engineers or designers as we are always facing new problems which involve a considerable amount of guessing—and in all designing a factor of compromise enters into the problem due to conditions. It may be that a great deal of our trouble results from the fact that we are getting a number of students who are in this 65–70 per cent range and this causes as much discouragement on the part of the employer as to the students themselves.

In closing, the writer would like to make the statement from his many years in machine designing, and from contacts with the various industries, that he does not feel the student need worry too much about his employer being impatient. It is honestly believed that he will be given every opportunity to prove his ability in following along the field of machine designing.

AUTHOR'S CLOSURE

The author is pleased with the comments his paper has brought forth and thanks those who have taken the trouble to write in their criticism.

Professor Church shows that machine design has not been neglected in the present-day curriculum. Even if we take out drawing, descriptive geometry, and mechanics, which are more or less common to all engineering students, we still have 16 per cent of the total time devoted to machine design, as compared to 11.3 per cent for power. Since the colleges are educating their students to be mechanical engineers and not training them specifically for machine design, this seems a reasonable proportion.

Professor Hartman stresses agreement in the responsibility of the employer in utilizing properly the product of the college. He has expanded this in a very creditable paper presented before the Society.[22]

[22] "Graduate Engineers in the Field of Design," by J. B. Hartman, MECHANICAL ENGINEERING, vol. 71, May, 1949, pp. 403–405.

Professor Luce brings out one very important point, namely, once the young graduate is on the job he spends as much time in one week learning the techniques of that job as he spends in a whole term in learning one of the many subjects he takes up in college. Naturally, he progresses much faster, and this is as it should be. Now he is training for particular work, whereas before he was preparing for a profession.

Mr. B. P. Graves is the only one from industry who submitted written comment. It is interesting to note that his company recognizes its responsibility in the further training of the college man and has taken steps to tide him over the transition from college to industry. The author agrees with him that the college man is impatient with drawing-board work. If industry would play down the drafting end of the job and stress the engineering importance, this attitude could be corrected. The graduate going into testing is called a "junior test engineer." Why not find a comparable title and do away with "draftsman" for this man? A good indication that this has an effect is the fact that many of our young men are willing to accept P-1 positions with the Goverment, even though that position entails drafting.

C. HIGBIE YOUNG.[23]

[23] Professor, Charge of Department of Machine Design, The Cooper Union School of Engineering, New York, N. Y. Mem. ASME.

REVIEWS OF BOOKS

And Notes on Books Received in the Engineering Societies Library

The Pennsylvania Railroad Company

CENTENNIAL HISTORY OF THE PENNSYLVANIA RAILROAD COMPANY, 1846–1946. By George H. Burgess and Miles C. Kennedy. The Pennsylvania Railroad Co., Philadelphia, Pa., 1949. Cloth, $5^1/_2 \times 8^3/_4$ in., illus., maps, tables, plates, xxvi and 835 pp., $3.50.

REVIEWED BY E. D. CAMPBELL[1]

SUCH a wealth of material is included in this history of the world's greatest railroad, that the work is a reference book on all matters connected with the development of the Pennsylvania Railroad. Not only is it a factual record, but its pages unfold a story which is a classic of the free-enterprise system at work in this country. As Mr. Clement, president of the Pennsylvania Railroad Company, so aptly states in his introduction, "The story which is told is primarily that of the Pennsylvania Railroad as a typical example of American business enterprise in the field of public service."

The authors are to be commended on their zeal to present only a factual narration of events and not delve into interpretations of causes and effects. I also like the manner in which the book is set up chronologically, inasmuch as the method is easily followed when used for reference work and historical reading.

Briefly, it is divided into three parts, the first being called Background and Beginnings; the second part covers the administration of each one of the eleven presidents including the present incumbent, Mr. M. W. Clement, to the year 1946; and the third is a résumé of the progress in the development of the Pennsylvania rolling stock.

In order to condense this review, I will follow these three divisions; however, the book has assigned a part number for each of the railroad presidents' administration.

The first part of the history follows the pattern of biographies as it depicts the birth and early struggles of infancy, youth, and approaching manhood of the enterprise.

Reading the first few pages of Part I, one concludes that competition was largely responsible for the birth of the

[1] Retired, former Vice-President, Charge Engineering, American Car and Foundry Co., New York, N. Y. Fellow ASME.

Pennsylvania Railroad. The book reveals that the State of Pennsylvania was apparently being by-passed in so far as trade with the West was concerned, because New York's Erie Canal on the north of the state and the Baltimore and Ohio activity on the south provided shipping facilities from the West to the East, the latter being mostly New York, the eastern seaboard, and the New England States.

The mountains of Pennsylvania also innocently contributed to the growth of the railroad infant inasmuch as the state canals were a failure owing to the necessity of crossing the Alleghenys to get to the gateway to the West, Pittsburgh, Pa.

The primitive highways proved woefully inadequate as well as exceedingly expensive. Hence the railroad was the answer and happy solution as future events showed.

Under the administration of J. Edgar Thomson the railroad grew to manhood, and the difficulties encountered and overcome provide stimuli in their reading. During this period, 1852 to 1874, one might conclude that the management began to evaluate improvements which affect the operation ratio.

Starting with the roadbed, the original track structure was one of longitudinal wooden stringers on which were laid strips of iron to furnish bearing surface for the wheels. This structure was replaced by steel T rail.

Passenger and freight cars were of wooden construction. The average freight-car capacity was approximately 10 tons or 20,000 pounds. The advent of the steel rail permitted wheel loads of locomotives and cars to be greatly increased. Greater motive power for handling longer trains was obtained, resulting in more revenue per train.

The elimination of slowdown curves and reduced grades lowered time schedules, usually to the railroad's advantage over competition.

One of the biggest improvements was the acquisition and betterment of terminal facilities. This activity regarding terminals during Thomson's administration was an important factor in the railroad's success and forms an interesting story well told by the authors.

Typical of the time, the company was beset with financial troubles in spite of its record and good rating. The moves and countermoves made to keep alive the now mature railroad make excellent reading as the development into maturity is so closely interwoven with our country's growth. In fact, a history of any of our older railroads is also a history of the U. S. A.

The history reveals that the roster of Pennsylvania Railroad presidents identified with epochs of tremendous strides in the road's progress, were engineers of world repute or had received their basic training in the engineering field. Mr. Rea, president from 1913 to 1925, was not only a great engineer but an outstanding figure in finance and organization. His administration saw the end of railroad expansion in this country.

From this time on, internal affairs, leading toward improvements in facilities to handle a rapidly growing freight and passenger traffic occupied the management's time.

The first World War, during which time all railroads were under government control, provided an aftermath of trouble with labor and the problem of depressed revenue. The famous Transportation Act of 1920 obviously required thorough study and execution of plans by all Class I railroads. Mr. Rea took a prominent part in those plans.

All are familiar with the marvelous record of the railroads made during World War II. Some are not mindful of the intensive preparatory work which the railroad's foresight prompted them to undertake on their own initiative.

As early as 1939, M. W. Clement who became president in 1935, announced that the Pennsylvania would spend $17,000,000 for new equipment and that cars set aside for retirement would be repaired and put in service. Electrification was extended to Harrisburg, Pa., thereby greatly improving schedules.

At present the Pennsylvania and all American railroads are confronted with perplexities and inconsistencies of governmental policy concerning the four forms of transportation: rail, water, air, and highways. It is inconceivable that the American people will not wake up in time to apply the brakes to a growing trend of governmental interference with railroad operation, and insist on harmonious co-ordination of all the forms of transportation.

The third part of the book, "Rolling Stock," is of value as a historical account of the progress made in the development of the Pennsylvania's rolling stock. It starts with wood-burning locomotives weighing 47,000 pounds up to their latest Diesel-electric of 6000 horsepower.

The chapters likewise follow the progress of Pennsylvania Railroad car design from 1849 to the present, for both freight and passenger cars. This part of the history is not as complete as the importance of the subject recommends. The advance and progress made in railroad cars for the last fifty years is a subject so neglected that many believe little progress has been made.

This thinking is at variance with the facts. The Pennsylvania Railroad figured prominently in the development of cars as well as locomotives.

This reviewer considered the history written primarily as a record and as such it will be very useful for reference work. It is not a book that one will want to take along on a vacation for light reading. However, it is a history containing many not commonly known side lights on railroad personalities and their activities.

A Professional Guide for Junior Engineers

A PROFESSIONAL GUIDE FOR JUNIOR ENGINEERS. Edited by W. E. Wickenden and Collated by G. R. Henninger. Engineers' Council for Professional Development, New York, N. Y., 1949. Paper-backed, 8 × 11 in., 55 pp., $1.

REVIEWED BY W. J. KING[2]

ALTHOUGH this excellent treatise is directed primarily at the junior engineer, most of it could be read with great profit by senior engineers, including engineering educators and administrators. This is particularly true of chapters 5 and 6, which deal in a very timely and effective way with the significant current issues of Legal Registration and Collective Bargaining for Engineers. In fact, it is not too much to say that this brochure of 55 pages should be regarded as "required reading" for anyone with a serious interest in the profession of engineering.

The first three chapters, under the captions: "The Engineer's Heritage," "The Threshold-Transition From Engineering Student to Engineering Graduate," and "The Engineering Graduate—Some Important Choices and Decisions Are Required," represent major contributions to the orientation of college students to the engineering profession during the early years of bewilderment and uncertainty surrounding the choice of a curriculum, the appreciation of specific courses, and the question of employment. There has been a tremendous need, among engineering students, for such wise and authoritative counsel as this Guide provides.

Even so, this reviewer would venture to take issue with one thesis which is reiterated several times in chapter 4,

[2] Melville Medalist, 1945; Professor, Director, Sibley School of Mechanical Engineering, Cornell University, Ithaca, N. Y. Mem. ASME.

captioned "Beginning Professional Practice." It is expressed first in the statement, at the bottom of page 21, that "the art of production and the directing of corporate effort depend so largely on knowledge which no school can impart." It would be illuminating if specific examples of this kind of *knowledge* could be adduced. Perhaps wisdom, judgment, and certain kinds of skills cannot readily be imparted by schools but certainly "knowledge" is the very stock in trade of the schools. There is, in fact, much evidence to indicate that it is very dangerous and expensive to defer the teaching of this kind of art and knowledge—allowing the junior executive to learn the facts of industrial life by practicing for a few decades on a real-life organization of men, money, and machines. The latter process is too slow and costly in mistakes. If the art of medicine and surgery were not taught in school, the medical profession would be in about as bad a mess as we have had in industry while the managers were learning the business by trial and error at the expense of the "patients." The colleges can and should teach more of the art and science of industrial management, and they probably would do so more effectively if industry were not allowed to siphon off so many of the best teachers.

The remaining chapters, 7, 8, and 9, constitute an outstanding treatise on the nature of a profession, in general, and the engineering profession in particular. Dr. Wickenden, whose untimely death in 1947 was a great loss to the engineering world, was certainly one of our most eloquent spokesmen for the professional ideal. His classic address "The Second Mile" is reprinted as chapter 9 in this treatise. Your reviewer has frequently urged that there is a need for an "Engineers' Bible" containing the authoritative "scriptures" and "gospels" of engineering, which would perform the same service of inspiration and guidance for the profession as the King James version has provided for Christendom. If this is ever compiled, Dr. Wickenden's chapters should surely be included among its "books," and their author should be numbered among the high priests of the engineers' "religion." Meanwhile many a present-day engineer might be saved from the dark depths of subprofessional conduct and the more sordid aspects of trade unionism by a thoughtful reading of this modern new testament. At any rate, it is certainly true that a great many engineering careers are blighted because of sins against these particular ideals and commandments—frequently out of sheer ignorance of what is *expected* of a first-class engineer.

Two appendixes further enhance the utility of the present Guide. Appendix A is captioned "Reading List for Junior Engineers," but, again, the list contains much solid fare for mature engineers. The selections are excellent and represent the kind of liberal education in the "humanities" that engineering colleges are now trying to cram into their curricula in their efforts to make truly professional engineers out of their technical graduates. Of course no such list can ever be complete, and the present critic would like to see a few references added right away. Under Philosophy there should surely be included some of A. N. Whitehead's writings, such as his "Science and the Modern World"; also the excellent four-volume anthology entitled "The World's Great Thinkers," published in 1948 by Random House; and William James's classic "The Varieties of Religious Experience." Two others that engineers would especially enjoy are "The Intelligent Individual and Society," by P. W. Bridgman, and Phillip Wylie's "Essay on Morals." Under the heading of History, Arnold Toynbee's "A Study of History" is conspicuously absent, and there is no history of science listed. Likewise, under Biography and Travel there are no biographies of engineers. Perhaps there should be a reference or two to other recent works dealing with the profession of engineering, such as "The Engineering Profession in Transition," published by the EJC in 1947, and the booklet entitled "On Views and Guides for the Electrical Engineer," published in 1948 by Prof. J. F. Calvert of Northwestern University.

The final Appendix is a Self-Appraisal Questionnaire, which asks some searching questions which most engineers would do well to ask themselves early and repeatedly during their careers.

In the writer's opinion this Guide is by far the best thing of its kind that has yet been published, not only because of the excellent job that Mr. Henninger has done in editing Dr. Wickenden's papers but also because it derives added authority and prestige from its sponsors, the Engineers' Council for Professional Development.

REVIEWED BY N. KONDO[3]

THE transition a man makes from a college graduate to a professional engineer is fraught with pitfalls as numerous as they are varied. This booklet, touching on the more prominent phases of professional development, can be of immeasurable aid to the perceptive neophyte. Just as the courses of study in college stress the method of attack rather than the solutions of specific problems, so this booklet offers a guiding philosophy with which the novice engineer can face his professional problems and be assured of arriving at rational conclusions.

While outlining a code of professional ideals toward which every engineer should strive, the author offers a wealth of valuable advice as practical as a handbook. The undergraduate engineer reading this booklet cannot help experiencing a sense of enhanced pride in his life-calling and at the same time become keenly cognizant of the responsibilities he assumes on entering the engineering profession.

Beginning with a brief history of the development of engineering as a profession, the author proceeds to describe the qualities found to be necessary for a successful career in engineering. Any prospective engineer may find it very beneficial to check his own personal traits with those enumerated by the author.

Upon graduation the young engineer will immediately be beset by numerous decisions which may affect the ultimate course of his career. "A wise choice is important in shaping his career, since one can gain or lose time at the starting line, although it seldom determines a man's final place in the race." The author offers some well-considered advice on such questions as whether to work for a large or small concern, near home or at a distance, in one organization permanently or to shift around. Other questions such as membership in unions, professional societies, and, most important of all, professional relationships and ethics are treated thoroughly. The counsel offered is practical enough for each engineer to apply to his own individual case and yet is maintained on a level sufficiently general that the en-

[3] Cornell University, ME, 1951. Student ASME.

Library Services

ENGINEERING Societies Library books may be borrowed by mail by ASME Members for a small handling charge. The Library also prepares bibliographies, maintains search and photostat services, and can provide microfilm copies of any item in its collection. Address inquiries to Ralph H. Phelps, Director, Engineering Societies Library, 29 West 39th St., New York 18, N. Y.

gineer does not lose sight of the overall objective.

The booklet concludes with the author's notable essay "The Second Mile." This composition has already been read by thousands of young engineers and has stimulated them to greater efforts toward professional development.

Inasmuch as engineers ordinarily do not do too much outside reading, the appended reading list covering practically every sphere of culture may be helpful to those who would like to acquire a general background of cultural knowledge.

If college training provides the engineer with technical tools, this booklet may be said to guide him in their use.

Treatise on Powder Metallurgy

TREATISE ON POWDER METALLURGY. Volume 1. By C. G. Goetzel. Interscience Publishers, Inc., New York, N.Y., Interscience Publishers, Ltd., London, England, 1949. Cloth, 5¾ × 9 in., 300 figs., 82 tables, terminology, author and subject indexes, xxvii and 778 pp., $15.

REVIEWED BY A. J. LANGHAMMER[4]

THIS book is well adapted for students, engineers, and others who wish to acquaint themselves with some of the fundamentals of powder metallurgy. It will also be useful for the purpose of review by engineers engaged in work on powder metallurgy.

The author treats twenty major subjects including principles, history, powder production, pressing, sintering, dies and punches, sintering atmospheres, and finishing or sizing. Each of these subjects is treated in considerable detail and, when possible, illustrations are used. These illustrations include photographs, curves, and data sheets. Such items as plant and equipment are shown pictorially. Other pictures include photomicrographs and drawings. There are many references and citations of papers and articles prepared and delivered heretofore by other writers. Due credit is given in each instance, and many of these articles are worthy of review.

The book gives numerous details, and in some of the material the author wanders a bit afield in that regard. This is notable, for example, in the discussion of finishing operations, and in the writer's opinion, does not constitute a demerit, since they supply information for readers who may not have broad practical training.

The contents are arranged in a logical sequence and the style makes for easy reading. Included are information and data that are quite abreast of present-day practice in a general way, as contrasted to material that would be out of date.

[4] President, Amplex Manufacturing Company Division of Chrysler Corporation. Mem. ASME.

Books Received in Library

AMERICAN SOCIETY FOR TESTING MATERIALS, Proceedings, vol. 48, 1948, Committee Reports and Technical Papers. American Society for Testing Materials, Philadelphia, Pa., 1949. Cloth, 8 × 9¼ in., 1354 pp., illus., diagrams, charts, tables, $12. (ASTM members $8.) This annual volume contains all reports and papers offered to and accepted by the ASTM during the year indicated. The table of contents and the subject and author indexes cover all papers and reports published by the ASTM during the year including Special Technical Publications and material appearing in the ASTM Bulletin. Discussions accompany their respective papers, and a synopsis of each paper is provided.

AMERICAN UNIVERSITIES AND COLLEGES, edited by A. J. Brumbaugh and M. Irwin. Fifth edition. American Council on Education, Washington, D. C., 1948. Cloth, 6½ × 9¾ in., 1054 pp., $8. Including the latest information, this book is an authoritative guide to accredited institutions of higher learning in the United States and its territories. In Part 1 there are concise but comprehensive descriptions of various aspects of American higher education. Part 2 supplies pertinent information about 820 accredited institutions. In the appendixes some further general and statistical data are given.

BASIC ENGINEERING SCIENCES, Solution to Problems, Part 2, Professional Engineer Examinations, New York State. By W. Glendinning, 5123 Bell Boulevard, Bayside, New York, 1948. Paper, 8½ × 11 in., 60 pp., $3. Useful to those preparing for Part 2 and Part 3 of the examinations for the License of Professional Engineer in New York State, this book presents questions and solutions to the problems of past examinations in practical application of basic engineering sciences. The major topics covered are hydraulics, mechanics and machine design, thermodynamics, and electrical principles and equipment.

BIBLIOGRAPHY ON SPRAYS, compiled by K. J. DeJuhasz. Published by Texas Company, refining department, technical and research division, New York, N. Y., August 1948. Paper, 8½ × 10¾ in., 98 pp., gratis. This comprehensive annotated list of over 300 articles and books is an expansion of an earlier listing, and is intended as an aid to the investigation of fuel-injection problems met in connection with Diesel engines, gas turbines, and jet engines. It also contains certain items on industrial sprays, dusts, and powders. The arrangement is alphabetical by author with a classified subject index.

CHAMBER'S SIX-FIGURE MATHEMATICAL TABLES, 2 vols. Vol. 1. Logarithmic Values. Vol. 2. Natural Values. By L. J. Comrie. D. Van Nostrand Co., Inc., Toronto, Canada, New York, N. Y., London, England, 1949. Cloth, 7 × 10¼ in., 576 pp. each, tables, $10. ($17.50 per set). Vol. 1 of this set provides tables of logarithmic values as follows: of numbers up to 100,000 in various ranges and intervals; of trigonometrical functions of angles in degrees, minutes, and seconds: of angle functions in degrees and decimals and in radians; of hyperbolic and gamma functions. Vol. 2 provides tables of natural values for trigonometrical functions of angles in degrees, minutes, and seconds; angle functions in degrees and decimals; circular functions (argument in radians); exponential and hyperbolic functions; also natural logarithms, powers, roots, reciprocals, factors, prime numbers, etc. Explanatory notes, conversion tables, physical and mathematical constants, and bibliographies of more extended tables appear in both volumes.

CYLINDER WEAR IN DIESEL ENGINES. By C. Høegh. Chemical Publishing Co., Brooklyn, N. Y., 1949. Cloth, 5½ × 8¾ in., 191 pp. plus Addendum, 52 pp., diagrams, charts, tables, $5. Of interest to all those concerned with Diesel engines, this book gives a critical analysis of the factors which influence the wear in Diesel-engine cylinders. Special attention is paid to large marine installations. Such factors as lubrication, fuel oils, deposits and abrasives, corrosion, and operating conditions are among those treated. References to selected literature are included as are the results of investigations made by the author.

DIESEL-ENGINE CONSTRUCTION FUEL SYSTEMS. By I.C.S. Staff. International Textbook Co., Scranton, Pa., 1948. Fabrikoid, 5 × 7¾ in., paged in sections, illus., diagrams, $2.50. In the construction section this practical book covers stationary and moving parts, valves and valve gear, and Diesel-engine accessories. Part two discusses various methods of fuel injection, including air and mechanical injection, and combustion systems.

DIESEL-ENGINE COOLING AND CONTROL. By I.C.S. Staff. International Textbook Company, Scranton, Pa., 1948. Fabrikoid, 5 × 7¾ in., paged in sections, illus., diagrams, charts, colored plate, $2.80. This book discusses methods and devices in a practical manner, effectively illustrated by a large number of clear diagrams. Part one considers the various features of cooling and compressed-air systems. Part two covers starting, reversing, governing systems, and oil-measuring devices.

DYNAMIC PRINCIPLES OF MECHANICS. By D. R. Inglis. Blakiston Company, Philadelphia, Pa., and Toronto, Canada, 1949. Linen, 6¼ × 9¼ in., 174 pp., diagrams, $4. This study of classical mechanics is written as a text for college juniors and seniors who have already studied calculus and general physics. Primarily a discussion of fundamental principles, there is a particular emphasis on dynamics, and the concept of vectors is introduced early and used often. Problems for student solution are in text following related material.

GAS TURBINES FOR AIRCRAFT. By F. W. Godsey, Jr., and L. A. Young. McGraw-Hill Book Co., Inc., New York, N. Y., Toronto, Canada, and London, England, 1949. Cloth, 6 × 9¼ in., 355 pp., illus., diagrams, charts, tables, $4.50. Of interest to aeronautical engineering students, aviation engineers, and those interested in the future of aviation, this book considers the gas turbine as an aircraft prime mover. Basic information is presented in the first three chapters. The next five deal with gas-turbine components and cycles, and the last three with controls and accessories, hybrid types of power plants, and the performance of aircraft powered by gas turbines.

ters, the expansion of certain sections, and the addition of new chapters on magnesium alloys and on corrosion and heat-resistant steel alloys. The general approach of the first edition has been retained—the correlation of phase diagrams, structures, and properties of alloys, proceeding in order from the simplest alloys to the most complex.

STRUCTURAL DESIGN IN WOOD. By C. Mackintosh. School of Applied Engineering, 233 So. Broadway, Los Angeles, Calif., 1946. Paper, $8^1/_2 \times 10^3/_4$ in., 100 pp., diagrams, charts, tables, apply. This book contains a series of lectures on the effect of the special properties of timber upon the design of structures. Methods of designing structures together with their joints are considered with the object of obtaining maximum strength, safety, and durability. The woods dealt with are Douglas Fir, Redwood, and Southern Yellow Pine. Numerous diagrams, references, and questions are included.

TABEL TIL BRUG VED ADDITION AF KOMPLEKSE TAL (Table for use in the Addition of Complex Numbers). By J. Rybner and K. S. Sørensen. Jul. Gjellerups Forlag, Copenhagen, Denmark, 1948. Paper, $9^1/_4 \times 12^1/_2$ in., 95 pp., charts, tables, 20 Danish Kroner. The object of this table is to facilitate calculations with complex numbers by making possible the addition or subtraction of such numbers in polar form. The numerical value R and the phase angle α of the sum are given as functions of the variables γ from 0 to 1 at intervals of 0.01 and φ from 0 to 180 deg at intervals of 1 deg. The explanatory test is printed in parallel columns of Danish and English.

TEMPERATURE AND HUMAN LIFE. By C. E. A. Winslow and L. P. Herrington. Princeton University Press, Princeton, N. J., 1949. Cloth, $5^1/_2 \times 8^3/_4$ in., 272 pp., illus., diagrams, charts, tables, $3.50. This book analyzes the effect of heat and humidity on human life and the effectiveness of artificial controls. It summarizes basic background knowledge dealing with the production of heat in the body and presents the results of experiments on the basic problems of thermal interchange between the body and environment. The fundamental objectives of air conditioning are considered and heating systems are discussed.

THÉORIE ET CALCULE DES ENGRENAGES HYPOIDS. By J. Capelle. Dunod, 92 rue Bonaparte, Paris (VI°), France, 1949. Paper $6 \times 9^1/_2$ in., 73 pp., diagrams, tables, 380 frs. This small book, devoted to the theory and calculation of hypoid gears, is intended for all those whose interest in and knowledge of the problem are considerable. In the development of the theory, both the analytic and geometric approach, have been used. A knowledge of advanced mathematics, including vector analysis, is assumed.

THERMOCINÉTIQUE. (Publications Scientifiques et Techniques du Ministère de l'Air.) By P. Vernotte. En Vente au Service de Documentation et d'Information Technique de l'Aéronautique; Magasin C.T.O., 2 Rue de la Porte-d'Issy, Paris, (XV°), France, 1949. Paper, $7 \times 10^3/_4$ in., 459 pp., diagrams, charts, tables, 1200 frs. This book considers the movement of heat, its propagation, and its thermodynamics. It starts with a presentation of the basic principles of thermokinetics. The field covered by this theory is then discussed in detail, followed by the third section, which considers applications to the measurement of thermal conductivity, etc. Abstracts of pertinent articles by the author are given in the appendix.

THREAD GRINDING AND MEASUREMENT. By A. C. Parkinson and W. H. Dawney. Sir Isaac Pitman & Sons, Ltd., London, England, and Pitman Publishing Corporation, New York, N. Y., 1949. Cloth, $5^1/_4 \times 8^3/_4$ in., 227 pp., illus., diagrams, charts, tables, 21s. This book serves as a text for beginners as well as a reference work for more experienced personnel on both the production and inspection sides of thread-ground work. Thread terms and definitions have been classified and explained in detail, the same applying to limit systems, in general, and their special applications to screw threads, worms, and hobs. In regard to thread measurement, a fairly considerable amount of space is devoted to the wire methods. A group of useful tables is included at the end.

THERMODYNAMIC CHARTS FOR COMBUSTION PROCESSES. Part 1. Text, 75 pp., diagrams, charts, tables, $2.60. Part 2. Charts, $2.40. By H. C. Hottel, G. C. Williams, and C. N. Satterfield. John Wiley & Sons, Inc., New York, N. Y.; Chapman & Hall, Ltd., London, England, 1949. Paper, $8^1/_2 \times 11^1/_4$ in. Part 2 contains a large modified-air chart, seven large burned-mixture charts, and two groups of tables: of equilibrium gas compositions for various combinations of ratios of C, H, O, and N; and of dimensionless functions of enthalpy, entropy, etc. Part 1 contains the descriptive and explanatory text containing smaller generalized thermodynamic charts and illustrative calculations. Examples of combustion power cycles to which these data apply are given, including the Diesel cycle, Otto cycle, ramjet, turbocompressor, and rocket.

TREATISE ON POWDER METALLURGY. Volume 1, Technology of Metal Powders and Their Products. By C. G. Goetzel. Interscience Publishers, New York, N. Y.; and London, England, 1949. Cloth, 6×9 in., 778 pp., illus., diagrams, charts, tables, $15. This is the first volume of a treatise which surveys, digests, and presents the whole field of powder metallurgy. This volume deals with the technology of powder-metallurgy processes, including a brief description of the underlying principles and a historical review. The production, properties, and testing of powders, as well as their conditioning for powder-metallurgy operations are discussed, and a survey of the currently available commercial grades of powders is made. The succeeding two volumes are to cover applied and physical powder metallurgy and to provide an extensive literature and patent bibliography.

TROLLEY CONVEYORS. By S. Reibel. McGraw-Hill Book Company, New York, N. Y., Toronto, Canada, London, England, 1949. Cloth, $6 \times 9^1/_4$ in., 265 pp., illus., diagrams, tables, $4. This book is written for those who study, design manufacture, operate, or purchase trolley conveyors. It shows what trolley conveyors will do, where they can be used, and how to lay out and use them. Standards of construction, original tables, data, and methods are included. New types of conveyors are described. There are many pictures, drawings, and charts. The tables are grouped in a section at the middle of the text, thus allowing the book to lie flat while the tables are in use.

WELDING METALLURGY, Iron and Steel. By O. H. Henry and G. E. Claussen, revised by G. E. Linnert. Second edition. American Welding Society, 33 West 39th St. New York, N. Y., 1949. Fabrikoid, $5^1/_4 \times 7^3/_4$ in., 505 pp., illus., diagrams, charts, tables, $2.50. Intended for use by those in the welding industries, this book discusses the welding metallurgy of specific materials and the effect of different elements on the welding process. Over 150 pages have been added to this edition containing new information on recently introduced processes and more information on the metallurgy of specific materials. A short bibliography has been added to each chapter of the book and an index has been added to the book itself.

ASME BOILER CODE

Interpretations

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Anyone desiring information on the application of the Code may communicate with the Committee Secretary, ASME, 29 West 39th St., New York 18, N. Y.

The procedure of the Committee in handling the Cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are then sent by the Secretary of the Committee to all members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and is passed upon at a regular meeting.

This interpretation is later submitted to the Council of The American Society of Mechanical Engineers for approval after which it is issued to the inquirer and published in MECHANICAL ENGINEERING.

Following is a record of the interpretations of this Committee formulated at the meeting of June 24, 1949, previously, and approved by the Council on August 9, 1949.

CASE NO. 1002

(Special Ruling)

(Reopened)

Inquiry: Par. U-13(f) of the Code authorizes, with certain limitations, the use of pipe in accordance with Specifications SA-53 and SA-135 for the pressure parts of unfired pressure vessels. May spiral welded pipe made in accordance with ASTM Specification A 139–42 be used as well as the above-named material?

Reply: It is the opinion of the Committee that, except for Submerged Arc Welding, material complying with ASTM Specification A 139–42 may be used for pressure parts of unfired pressure ves-

sels under Par. U-13(f) on the same basis as Specifications SA-53 and SA-135. For Submerged Arc Welding, material of these three specifications shall be selected which has the following chemistry limitations: C 0.30 max, Mn. 0.30 to 0.80, S 0.05 max. Furthermore, this selected material shall be either killed or semi-killed steel. The working stresses shall be the same as those provided for Specification SA-135 Grade A, in Table U-3.

ADDITION TO CASE NO. 1074

Case No. 1074, Paragraph (3)*f* of the Case be amended as follows:

"No low temperature impact tests are required for any of these materials or for any deposited weld metal, the composition of which is within the range of composition of the specifications permitted for use under Paragraph (2) for use at —325 F temperature and above. If the deposited weld metal does not meet this requirement, impact tests of the weld metal shall be made in accordance with the requirements of Par. U-142. If the impact specimen bends, without fracture, it shall be considered to have met the requirements."

CASE NO. 1099

(*Special Ruling*)

Inquiry: May rod stock be substituted for castings conforming to Specification SB-61, now required under ASME Boiler Construction Code, Section I, Appendix A-20(b) for use in the fabrication of casings for fusible plugs?

Reply: Phosphor bronze rods meeting the requirements of ASTM B 139-48 Tmay be substituted for castings conforming to SB-61 for the manufacture of fusible plug casings A-20 (b) Appendix to ASME Boiler Construction Code. The use of the free machining grades B1 and B2 is recommended but Grades A, C, and D are equally acceptable. All rods for this purpose must be relief annealed to the extent that specimens removed therefrom will pass the standard ASTM Mercurous Nitrate test.

CASE NO. 1100

(*Special Ruling*)

Inquiry: In view of the fact that Supplement No. 1—B16e-1939 was approved by the American Standards Association on April 27, 1949, may these revised ratings now be used in the design and construction of boilers and unfired pressure vessels?

Reply: It is the opinion of the Committee that Tables A, B, C, and D with their notes in Supplement No. 1—B16e6-1949 of B16e-1939 may be used to replace the corresponding parts of present table A9 "Service Pressure Ratings for Steel Pipe Flanges and Flanged Fittings" and that revised Table P15 "Maximum Boiler Pressure for Use of American Steel Pipe Flanges, Fittings and Valves" (as published in the June issue of MECHANICAL ENGINEERING) may be used in place of the present Table P15. Minimum wall thickness of welding and valves shall be as given in Table E of ASA B16e6-1949.

CASE NO. 1101

(*Special Ruling*)

Inquiry: May an Adamson furnace, meeting with all of the requirements of P-242 except riveting, be assembled by welding?

Reply: It is the opinion of the committee that an Adamson furnace may be assembled by welding, providing:

1 The requirements of Par. P-242, (1), (2), and (3) for dimensions of flue flanges and rings are met.

2 The outside edges of the flue flanges are attached to the Adamson rings by full fillet welds.

3 The inside edges of the Adamson rings are welded to the flat portions of the flue flanges by full fillet welds.

4 The welds are stress relieved in accordance with Par. P-108.

Proposed Revisions and Addenda to Boiler Construction Code

IT IS the policy of the Boiler Code Committee to receive and consider as promptly as possible any desired revisions of the rules and its codes. Any suggestions for revisions or modifications that are approved by the Committee will be recommended for addenda to the Code, to be included later in the proper place.

The following proposed revisions have been approved for publication as proposed addenda to the Code. They are published herewith with corresponding paragraph number to identify their location in the various sections of the Code and are submitted for criticism and approval from anyone interested therein.

It is to be noted that a proposed revision of the Code should not be considered final until formally adopted by the Council of the Society and issued as pink-colored addenda sheets. Added words are printed in SMALL CAPITALS; words to be deleted are enclosed in brackets [ ]. Communications should be addressed to the Secretary of the Boiler Code Committee, 29 West 39th St., New York 18, N. Y., in order that they may be presented to the Committee for consideration.

PAR. U-208(e) (*revision*)

(e) **Retests** (1) SPOT EXAMINATION. When a spot has been examined and the welding does not comply with the minimum quality requirements referred to in (b) for radiographing or in (c) for sectioning, TWO additional spots shall be examined by either method in the SAME SEAM AT LOCATIONS TO BE SELECTED BY THE INSPECTOR, ONE ON EACH SIDE OF THE ORIGINAL SPOT TO DETERMINE THE LIMITS OF THE DEFICIENT WELDING AND IF THE WELDING AT EITHER OF THESE SPOTS FAILS TO comply with the minimum quality requirements IN (2) FOR RADIOGRAPHING OR IN (c) FOR SECTIONING, ADDITIONAL SPOTS SHALL BE EXAMINED UNTIL THE LIMITS OF UNACCEPTABLE WELDING ARE DETERMINED. IN ADDITION, THE INSPECTOR MAY REQUIRE THAT AN ADDITIONAL SPOT BE EXAMINED BY EITHER METHOD AT ONE LOCATION SELECTED BY HIM IN EACH SEAM NOT PREVIOUSLY EXAMINED ON WHICH THE SAME OPERATOR HAS WELDED AND THAT, IN CASE ANY ADDITIONAL SPOT FAILS TO COMPLY WITH THE MINIMUM QUALITY REQUIREMENTS, THE LIMITS OF UNACCEPTABLE WELDING BE DETERMINED AS ABOVE DESCRIBED. All rewelded areas shall be reexamined as required by the inspector and shall comply with the minimum quality requirements.

Errata

In Case No. 1092 on page 615 of the July, 1949, issue of MECHANICAL ENGINEERING the reference to "Par. U-13 (b)" should read "Par. U-13 (h)."

Add as (5) to Case No. 1092:

(5) Each casting shall be marked to show the class number and producers' name or identification symbol. These markings shall be transferred if necessary to show on the finished part.

Digests of ASME Meetings Papers

DIGESTS of available preprints of papers presented at the ASME Semi-Annual Meeting, held in San Francisco, Calif., June 27–30, 1949, appear in this month's ASME TECHNICAL DIGEST, pages 756–760.

Pamphlet copies of the complete papers are available at 25 cents each to members and 50 cents each to nonmembers from ASME Order Department 29 West 39th St., New York 18, N. Y.

THE ENGINEERING PROFESSION

News and Notes

As Compiled and Edited by A. F. Bochenek

Employment Outlook for Engineers

Expansion of Profession Foreseen

ENGINEERING is the third largest profession in the nation and one of the fastest growing, according to statistics compiled by the Bureau of Labor Statistics, U. S. Department of Labor, which are to be published this fall for use in vocational counseling of veterans and students.

Within 10 or 12 years, the number of graduate engineers may increase by 100,000 to a total of 450,000. Engineering-school enrollments are now so high that many graduates of the next few years may not find jobs in engineering, and may be competing with law, business, and liberal-arts graduates for administrative, sales, and other jobs in industry.

These are but two of the main conclusions of the Labor Department's comprehensive study of the employment outlook for engineers. Other major conclusions are:

1 After the next few years, if engineering enrollments decline to levels suggested by past trends and if the oversupply of graduates is absorbed into other types of work, opportunities for new graduates will be considerably better.

2 Over the next decade engineering-school facilities and instructional staff should be provided to meet a demand for roughly twice as many graduates as were turned out annually in the prewar decade.

3 Salaries of younger engineers have increased relative to those of more experienced men in recent years. Earnings of beginning electrical engineers, for example, increased 66 per cent from 1929 to 1946, those for engineers with 10 years of experience 22 per cent, and those of men with 25 years of experience 11 per cent.

4 The greatest increase in earnings of engineers occurs in the first ten years of experience; after about 30 years of experience there tends to be a leveling-off of average salaries.

5 Good training is increasingly important in the profession. Engineers with the master's degree earn, on the average, slightly more than those with the bachelor's, but men with the doctor's degree earn considerably more than either of these groups.

6 The profession offers employment flexibility; between 1939 and 1946 more than 30 per cent of the engineers changed employment location from one state to another, at least 25 per cent changed their industry field, and from 8 to 14 per cent of those employed in each of the major branches of the profession in 1939 had moved to another branch by 1946. Close relationship among the branches and similarity of basic training are also reflected in the fact that more than 20 per cent of the engineers were educated in a branch of engineering other than that in which they were employed in 1946.

Trends in Employment

The number of engineers increased nearly ten times between 1890 and 1940, rising from 27,000 to 260,000. By the spring of 1948, the engineering profession may have numbered around 350,000—an increase of about 38 per cent since 1940, stimulated by the great wartime dependence on technology, by expansion of research activity of industry and the Federal government, and by the desire of industry to make practical use of recent technological discoveries.

Numbers in the profession actually increased three times as fast as would be accounted for by the growth of the five major industries in which most engineers were employed. The advance of scientific knowledge and its practical application in industrial operations, the extension of research and development work in industry and government, and the new uses of engineering methods in administration, sales, and other types of work, all underlie the extension of industry's use of engineers. Fig. 1 shows how the number of workers per engineer has decreased since 1890.

If use of engineers by industry continues in line with past trends, total engineering employment may rise roughly to 450,000. The expansion would average 8000 jobs per year from 1948 to 1960. This figure was given not as a forecast, but only as a suggestion of the magnitude of future demand.

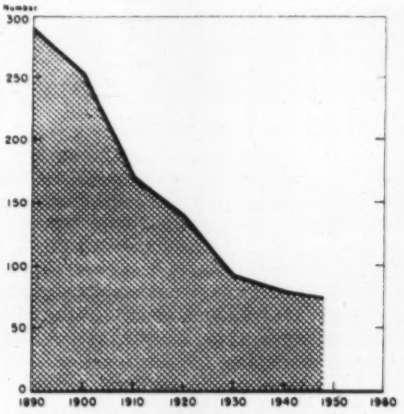


FIG. 1 NUMBER OF WORKERS PER ENGINEER

(Gainful workers in manufacturing, mining, construction, transportation, and public utilities, compared to number of engineers in the United States.)

Replacement Needs

In addition to filling the new jobs, the engineering profession will be faced by vacancies created by death, retirements, and transfers to other occupations. Between 1940 and 1950, these losses will number 55 to 60 thousand. In the following decade, they will probably amount to 80 thousand. The sum of the losses and the new jobs points to an annual replacement need during the next few years of 17,000 to 18,000 new engineers.

Supply of Graduates

The annual supply of engineering graduates rose from an area of 7000 in the 1920's to 10,000 in the 1930's. Because of the tremendous wartime expansion in engineering-school enrollments, the number of annual graduates is reaching unprecedented heights. Last year some 32,000 engineering students were graduated. In 1949 the total was estimated as 41,000. In 1950 it will probably be 47,000; in 1951, 36,000; and in 1952, 29,000. How this compares with prewar trends can be seen in Fig. 2.

A comparison of the estimated supply of and demand for engineering graduates leads to several conclusions. The number of graduates will greatly exceed the number of engineering job openings in the next few years. After that, if past trends affecting enrollments should continue to operate, the annual demand for graduates and the supply of new graduates would roughly balance.

It should be noted that the foregoing appraisal of the outlook is based upon the assumption of a high level of general economic activity, and that difficulties which face the graduates of the next few years would be intensified by a decline in general business conditions.

The foregoing evaluation is based solely on comparisons of the prospective demand with the expected supply of engineering graduates, and does not allow for the likelihood that some engineering jobs will be filled, as in the past, by men without engineering degrees. For example, no less than 35,000 persons without such degrees entered the profession during the 1920's. Even during the depression decade of the 1930's, at least 26,000 nongraduates entered the profession. Men who were not engineering graduates continued to enter the field during the war, as shortages of trained personnel developed. In view of the long-run trend to-

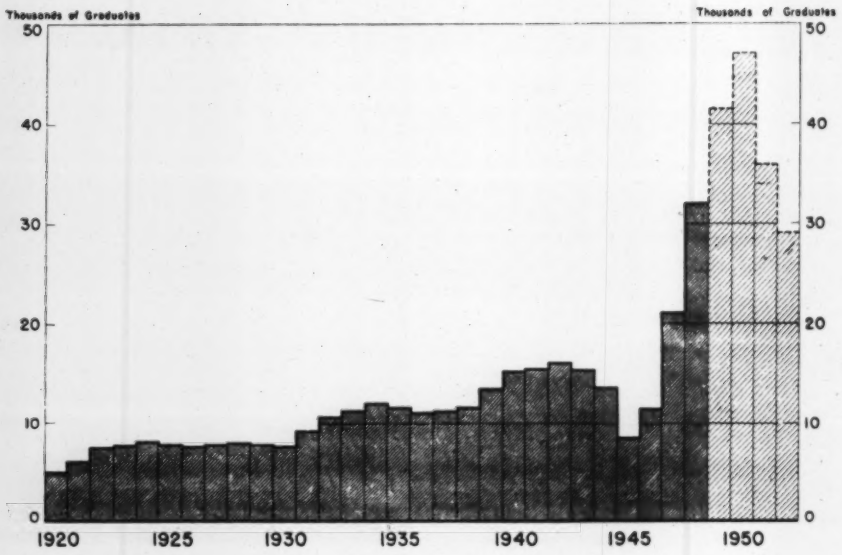


FIG. 2 NUMBER OF ENGINEERING GRADUATES
(Annual number of baccalaureate and first professional degrees granted.)

ward requiring formal engineering training and the ample supply of graduates, it seems likely that nongraduates will have greater difficulty in getting jobs than in recent years. To the extent that they may succeed, however, opportunities for graduate engineers would of course be fewer than herein estimated.

Occupational Mobility

The report also contains interesting information on the ability of engineers to shift from one branch of engineering to another. From 8 to 14 per cent of the engineers employed in each of the five major branches of engineering in 1939 moved into some other branch by 1946. In this shift, mechanical engineering gained most percentagewise, while civil engineering lost.

Approximately 22 per cent of the engineers shifted from one major type of employer to another. These changes reflect the principal sources of employment for engineers during the war and postwar years. Between 1939 and 1943 employment in private firms and in the Federal government increased chiefly at the expense of state and local governments and self-employment. From 1943 to 1946, relatively more engineers transferred from public employment to private industry than vice versa.

At least 25 per cent of the engineers changed their industry fields during the seven-year period; these changes appear to reflect the high wartime demands for engineers in the "heavy" or durable-goods industries.

More than 30 per cent of the engineers changed their employment location from one state to another between 1939 and 1946. This is a greater proportion than was involved in any of the other types of changes analyzed. The majority of those who moved from their 1939 employment location did so by 1943.

In 1946, 15 per cent of those employed as mechanical engineers were educated in some other branch. Of these 3.4 per cent were electricals, 2.2 were civils, and the remainder from other branches.

Copies of the report to be published this fall, may be ordered from Superintendent of Documents, Government Printing Office, Washington 25, D. C.

Dr. Kettering on Men and Ideas

PROBLEMS aren't solved with fancy apparatus but in a man's head," according to Charles F. Kettering, Fellow ASME, retired General Motors Research Laboratories Division director, who along with the "barn-gang" that developed the relay-controlled ignition and first automotive electric self-starter, were honored in Dayton, Ohio, July 22, 1949, the 40th anniversary of the incorporation of the Dayton Engineering Laboratories Company.

Comparing the work of early automotive inventors with that of present-day scientists and engineers, Dr. Kettering made some cogent remarks about men and engineering ideas.

"We must never impose limits on the minds of men," he said. "We can have a brilliant future, a future we can't even visualize now, if we continue to encourage our inventors and technical men. Industry can't afford to do otherwise.

"Today," Dr. Kettering asserted, "no industry, large or small, can be poor if it cultivates a harvest of creative ideas and has the gumption to develop them. A 'barn-gang' has just as much opportunity today as it had 40 years ago—in fact, I believe it has more.

"A smart industry today believes in scouting for good technical men and giving them the laboratory tools to work with. It also gives the customer the wealth of products that whole teams of technical experts can turn out. We must encourage and promote those fellows," Dr. Kettering declared.

The original company, now established as four GM manufacturing divisions under the Delco trade name, was incorporated July 22, 1909, by Dr. Kettering and cofounder Col. E. A. Deeds, Assoc. ASME, both National Cash Register Company employees at that time. Colonel Deeds now is National Cash Register board chairman.

They were joined by William A. Chryst, Mem. ASME, retired Delco Products chief engineer who shared their pioneering venture, and surviving shop helpers who at one time or another worked in the loft of Colonel Deeds' barn on Dayton's Central Avenue.

Dayton Engineering Laboratories Company, which Mr. Chryst compressed into the "Delco" trade name, started Dr. Kettering on his career as an independent inventor in the automotive field.

It began during spare time in a small shop outfitted on the second floor of the Deeds barn. There in 1908 Dr. Kettering, Colonel Deeds, and Mr. Chryst, also an NCR engineer, began tinkering with the ignition of the "Suburban Sixty," an automobile Colonel Deeds had built for himself. Mr. Kettering visualized a complete package to include ignition, self-starter, generator, and lighting system, basically what the Delco System is today.

This gadget literally shoved Delco into industry's mainstream, although Dr. Kettering hadn't planned to become a manufacturer. Rather, he had intended to use income from inventions and patents to finance new research and expand his fledgling laboratory.

Local Engineers Approve Smoke Ordinance

A SERIES of meetings aimed at encouraging engineers to participate in community affairs was recently inaugurated by the Piedmont Section of The American Society of Mechanical Engineers at Thacker's Restaurant, Charlotte, N. C.

James E. Campbell, smoke-abatement engineer of the city of Charlotte, described the proposed smoke-abatement ordinance under consideration by the City Council. From the questions and discussion provoked by Mr. Campbell's talk, it was apparent that local engineers were generally sympathetic with the aims of the ordinance and were of the opinion that the ordinance would be effective in promoting comfort and cleanliness for themselves and their neighbors.

According to Mr. Campbell, one of the principal features of the proposed ordinance prohibits "dense" smoke from commercial and industrial stacks. The ordinance defines dense smoke as being any exhaust from a stack which contains 40 per cent or more carbon, ash, or other dark particles. However, plants are allowed to turn out dense smoke for a period of two minutes out of each fifteen, or six minutes out of an hour when building a fire or cleaning the furnace. The proposed ordinance also prohibits more than 0.85 lb of fly ash per 1000 lb of exhaust from the stack.

Other important features of the proposed ordinance include the prohibiting of open fires of any type within the city, and it requires that within one year of its passage, all commercial, industrial, or apartment heating systems be mechanically fired.

Licensing for the Engineering Profession

Implication of "Right to Work" Discussed

IF engineering licensing is to be effective, the engineering profession itself must take responsibility for the policing function in two principal areas: preventing incompetent and unethical practice by licensed and unlicensed individuals, and keeping the conditions of granting a license so that no other purpose will be served but that of barring the incompetent and the unethical.

This admonition was made by a lawyer, John L. Waddleton, manager, labor section, legal division, Allis-Chalmers Manufacturing Company, Milwaukee, Wis., in a paper, "Licensing for the Engineering Profession," presented at the industry-college forum on the development of the young engineer, held during the 1949 Annual Meeting of the American Society of Engineering Education, Rensselaer Polytechnic Institute, Troy, N.Y., June 20, 1949.

Fundamental Principles

Two fundamental legal principles were involved in the exercise of these responsibilities, Mr. Waddleton said. The first was the "right to work" implicit in the Fifth and Fourteenth Amendments to the Federal Constitution. The second and more important was the "right and duty of the government to use its police power to protect the general welfare and interests of the public."

More Difficult Task

In the matter of preventing practice by the incompetent, the engineering profession has a much more difficult job than the medical and legal professions because there was not, in engineering, as there was in the medical and legal fields, the channelization or focusing of the practice toward or at a particular point, he said.

"For example, one cannot practice any amount of law without finding it necessary to appear in the courts. As a result, denying the unlicensed access to the courts automatically prevents substantial unlicensed law practice.

"Likewise, one cannot develop any amount of medical practice without issuing prescriptions or hospitalizing patients. Thus denial of access to hospitals and refusal to honor drug prescriptions of the unlicensed again automatically prevents unlicensed medical practice in those areas."

Lacking these advantages, he said, the engineering profession must devise some agency to take over the "disagreeable" task of filing "complaint or initiating proceedings" that may result in an engineer's losing his license.

Right to Work

In determining the qualifications for licensing, the engineering profession has a discretionary power, almost absolute, to foreclose the rights of individuals to work in the fields of professional engineering. By the imposition of too arduous an examination, the engineering profession may be denying some young man who has completed an engineering course training in a good school the right to practice in the profession of his choice, and thereby unwittingly violate the legal principle of the right to work, a violation made common by the strictures imposed by many unions upon the nonprofessional worker.

Zealous regard for the protection of the public interest in the matter of licensing of engineers, Mr. Waddleton warned, provides the occasion for actual but unwarranted deprivation of the right to work. In this connection Mr. Waddleton referred to a statement from the November, 1947, meeting of the National Council of State Boards of Engineering Examiners in New York.

The statement said:

"No longer will a national certificate be issued simply on the basis of graduation from an approved engineering school coupled with four years of satisfactory experience.

"Applicants must now have a record of ten years in the practice of engineering and must pass a written examination approved by the Council."

Such an extension of the qualification for certification could well result in the deprivation of the right to work in the profession unless it was true that the extension was necessary for the protection of the public.

"In the same report," Mr. Waddleton continued, "it is also noted that in the State of New York out of 40,000 applications for licenses, 20,000 were denied, and some of those unable to secure a license were practicing as engineers.

"The question can be frankly asked, were all 20,000 whose applications were denied of such a degree of incompetence that their practice of the profession would have endangered the public interest?"

Points for Consideration

In conclusion Mr. Waddleton posed the following points for consideration of the engineering profession: (1) The practice of engineering is sufficiently affected with the public welfare to warrant proper licensing regulations restricting the right to work in the field; (2) legislative grants of broad, discretionary authority to examining boards will be sustained in the courts; (3) the exercise of such discretionary power by the boards will also be sustained by the courts unless it is wholly arbitrary or unreasonable; (4) therefore, the preservation of the right to work in the profession is to a large extent the responsibility of the profession itself; (5) the right to work as guaranteed by our Federal Constitution is one of the promises we have made to ourselves down through the years; (6) it is one of the promises we give to our children when we send them to engineering schools, to medical schools, and to law schools; and (7) where the effectuation of that promise falls within the jurisdiction of your profession, let steps be taken that it not be "lost through obsolescence."

Professional Development

ORGANIZATION of working committees, composed of engineers in industry and faculties of local engineering schools in the centers of industrial activity, to study the needs of young graduate engineers during their first four to six years out of school, and to develop a joint program of education and training which would be meaningful alike to the employee, industry, and educators, was urged recently by T. Keith Glennan, president, Case Institute of Technology, Cleveland, Ohio.

ASEE Annual Meeting

Mr. Glennan made the suggestion at a panel discussion on professional development of the engineering graduate in industry during the annual meeting of the American Society for Engineering Education held in June of this year at Rensselaer Polytechnic Institute, Troy, N. Y.

While there seemed to be a unanimity of opinion of what industry wants in the way of engineering graduates, and while many of the larger companies supported orientation programs ranging from two months to two years, the plans had little in common, he said, except for orientation features. Little thought seems to have been given to the real ends to be achieved in dealing with the young engineer as a new employee. These ends, which are the crux of the problem, are the responsibility of industry and the educators. Only when they develop an understanding of the common problems will they be able to converse as partners in an enterprise, and develop a program from which all shall benefit, Mr. Glennan concluded.

Canadian Transfer Rates to Junior Grade Higher

THE Engineering Institute of Canada, the over-all engineering society for Canadian engineers, which sponsors student-branch activities in 11 Canadian engineering schools, is more successful than is The American Society of Mechanical Engineers in the number of student members who transfer to the junior grade following graduation.

According to L. Austin Wright, secretary EIC, 89 per cent of EIC student members become junior members as against the transfer rate of 60 per cent for ASME student members.

Engineering students enrolled in all branches of engineering at Canadian schools currently number 12,604, of which approximately a fourth hold EIC student memberships. ASME sponsors student branches with a total membership of 623 in three Canadian schools.

On the basis of enrollments in the fall of 1948, it has been estimated that American engineering schools will graduate more than 150,000 engineers in the next four years. During 1949 ASME student-branch membership reached 21,000. If this enrollment and the 60 per cent transfer rate are maintained, the ASME can expect a vigorous growth in the next few years.

First Pan-American Engineering Congress Held in Brazil

Union of Pan-American Engineering Societies Proposed

THE engineering profession of the Western Hemisphere held its first Pan-American Engineering Congress at the world-famous Quitandinha Hotel, about an hour's drive from Rio de Janeiro, Brazil, July 15–24, 1949.

In addition to a comprehensive technical program which consisted of more than 300 papers, the major achievement of the Congress was a draft of a charter of the proposed Union of Pan-American Engineering Societies (UPADI).

The United States was represented at the Congress by 43 engineers. Many of these were in Brazil solely to attend the Congress; others combined the trip with vacation or business; still others were representatives of U. S. companies in Brazil who actively participated in its organization and management.

For a week prior to the Rio de Janeiro meeting, July 9–14, delegates and representatives of the various engineering societies in Latin America attended a preliminary and organizational meeting in Sao Paulo. This meeting was under the auspices of the South American Union of Associations of Engineers (Union Sudamericana de Asociaciones de Ingenieros—USAI). USAI was founded in 1935 as a Latin-American association by such outstanding engineers as Francisco Marseillan, Francisco Mardones, Jose Buzzetti, Luiz Giorgi, and Francisco Saturnino de Brito, filho.

Pan-American Town Meeting

Through the efforts of USAI, the First Pan-American Engineering Congress was called as a "town meeting" of engineering societies in the Western Hemisphere. Its aim was to discuss common problems and professional objectives. The Congress beginning July 15 was preceded by a week-long meeting at Sao Paulo where representatives from all the Americas had gathered to draft a charter for the proposed Union of Pan-American Engineering Societies.

U. S. delegates attended the preliminary Sao Paulo meeting as observers only, since U. S. engineering societies are not members of USAI. Casting no votes they were invited nevertheless to contribute to the preliminary draft of the charter.

U. S. Delegation

The United States delegation was selected by and represented the Engineers Joint Council. It was headed by S. S. Steinberg, dean, University of Maryland. He was assisted by William H. Carson, dean, College of Engineering, University of Oklahoma. The various societies further were represented at the Congress by Jacob Feld, E. F. Hamilton, Kenneth W. Markwell, Fred T. Agthe, Sherwin F. Kelly, Carl W. Westphal, R. E. W. Harrison, Paul Cook, Lt. Gen. R. A. Wheeler, C. Dana McCoy, Omar Strange, William McCudden, L. J. Coulthust, William E. Worcester, E. Gruenwald, and Fred C. Rudge.

The American Society of Mechanical Engineers was represented by the following honorary vice-presidents: Dean Carson, L. J. Hughlett, R. E. W. Harrison, A. J. Ackerman, and Joseph Pope.

Decision for U. S. participation in the proposed UPADI will rest with the Engineers Joint Council. It was the unanimous opinion of the U. S. delegates at the conclusion of the Congress that the UPADI program presented desirable long-range objectives, and that the proposed union should have the support of U. S. engineering societies.

A Latin-American Project

UPADI as an over-all organization embracing all engineering societies of the Americas was an idea of Latin-American engineers for which U. S. engineers can claim no credit. Its origin stems from recognized needs for more effective communication of technical knowledge among engineers having similar interests, higher professional standards, and more joint activities for promoting personal contacts among the engineers of the Americas.

The charter for UPADI, evolved at the Sao Paulo meetings, is being carried by the various delegates to their respective countries in Central America and Mexico, Cuba, Canada, and the United States for action by their respective engineering societies. Upon acceptance by 15 countries, UPADI will come into being and a meeting will be held by delegates from the participating societies to undertake a program of implementation and organization for UPADI.

Hydroelectric Plant Visited

The story of Brazil's recent industrial development was dramatically told by trips especially arranged for the delegates to the Congress. Among the trips from Sao Paulo was one to the great hydroelectric installation at Cubalao which was planned and engineered by A. W. K. Billings of the Sao Paulo Tramway, Light and Power Company. Representing the company and acting as host to the engineering guests at a luncheon in Santos was Adolph Ackerman, executive of the company. Other visits were made to a coffee fazenda, the power plant at San Amaro, and a ceramic plant.

On July 14 the delegates were taken from Sao Paulo to Rio de Janeiro on a new stainless-steel train and Diesel locomotive on the Central do Brasil. These cars represent a partial shipment of 80 new air-conditioned stainless-steel cars presently being imported to relieve the difficult transportation condition existing between these two important centers of Brazil.

Brazilian Steel Center Inspected

On the trip to Rio de Janeiro the engineers stopped at Volta Redonda to visit the steel center of the country. Possessing at least a quarter of the world's iron reserves, the development of Brazil's steel industry proved of tremendous interest not only to engineers from countries without a steel industry but also those to U. S. engineers who considered it one of the most modern plants in the world.

Comparatively few field trips were taken by the Congress during its week of meetings at Quitandinha. The efforts of the delegates were devoted almost exclusively to reporting on the various papers presented at the meeting.

High standards were set for the evaluation of all papers, and those that were recommended for publication or abstraction represented substantial contributions to engineering literature.

Technical Agenda

The agenda for the Congress was purposely made broad to facilitate presentation of papers on a wide variety of subjects. Running throughout the papers prepared for various categories or specialized fields were studies made on the power facilities, capacities, construction programs, industrial economics, and transportation facilities of the various countries.

It was the concensus that if UPADI should materialize as a cohesive force binding the engineers of the Americas into a closer working relationship, such a development would be an important professional contribution to the development of the Americas. It would provide the basis for interchange of technical information on common problems. [Based on a report prepared by Lloyd J. Hughlett.]

British Management Institutes Merge

AN announcement in *Engineering* (June 17, 1949) that an agreement has been signed intended to bring about a merger between the British Institute of Management and the Institute of Industrial Administration, points up what appears to be a trend toward consolidation of British technical agencies.

In 1947 the Institution of Automobile Engineers amalgamated with the Institution of Mechanical Engineers as the Automobile Division of the IME. Under the terms of the amalgamation the Automobile Division retained a large degree of autonomy, and members of the Institution of Automobile Engineers became corporate members of the IME.

In the merger of the management institutes the Institute of Industrial Administration, which has been in existence for 30 years and has a membership of 6000, will also retain its separate identity, and its professional activities will continue unchanged. Its executive management, subject to the control of its own council, however, will be undertaken by the staff of the British Institute of Management. The merger will be completed in the second stage, which is expected to come into effect in two or three years' time.

Planning for CIOS 1951 Congress Well Under Way

U. S. to Report on Four Topics

AMERICAN management engineers have been assigned the task of preparing comprehensive summaries of developments in four related fields of management for presentation at the Ninth International Management Congress, which is being sponsored by the International Committee for Scientific Management, known internationally as CIOS, and is to be held in Brussels, Belgium, in 1951.

The tasks were assigned by the CIOS Belgium National Committee which is responsible for the technical program, and the practical arrangements for study trips and social events.

U. S. contribution to the Congress will be sponsored by the National Management Council which represents U. S. management organizations in CIOS.

Of the 13 management topics selected for discussion at the Congress, the following four have been assigned to the National Management Council: (1) Work measurement including methods of establishing production standards; (2) procedures in public administration for decreasing unit cost of operation and improving services; (3) education for management; and (4) work simplification.

British management will prepare reports on two topics: structures of large enterprises, and statistical quality control. Sweden will do one on working methods and efficiency of top managers; France on how to interest personnel in the success of an enterprise; Switzerland on job evaluation; the Netherlands on flexible and variable budgets; Belgium on tested procedures for reducing cost of distribution; Norway on home design and simplification of household routines; and Canada on comparison of exceptional and poor farm-management routines used in the same geographical area.

No Individual Papers to Be Presented

To achieve optimum utilization of the relatively little time available to delegates for exchange of information, no individual papers will be presented. Presentations will consist solely of exhaustive summaries of particular topics by appointed representatives of CIOS national councils and committees.

The summaries will not be confined to national aspects of subjects, but will represent the collaborative effort on an international level of all affiliates of CIOS bodies. For example, the National Management Council is collaborating with the Norwegian National Committee in its summary on progress in home and apartment design in relation to simplification of household routines.

CIOS Membership

CIOS is a private international federation of the representative national management bodies of the following 16 countries: United States, Great Britain, Australia, Canada, Brazil, France, Belgium, the Netherlands, Finland, Norway, Denmark, Sweden, Austria, Czechoslovakia, Switzerland, and Greece.

CIOS has two types of members: national committees, and national councils or institutes. National committees are in effect societies whose membership is open to groups as well as to individuals. Belgium, Brazil, Czechoslovakia, France, Greece, and the Netherlands are represented in CIOS as national committees. Several of these committees collaborate unofficially with other management groups in their respective countries.

CIOS national councils, called "roof organizations," as a general rule do not admit individuals as members. Two of them, U. S. National Management Council and British Institute of Management, admit business firms and educational institutions. Many of the national councils include among their members chambers of commerce, trade unions, and professional groups of engineers, consultants, accountants, psychologists, and others.

National Management Council

ASME is a member of the National Management Council; other members are: American Management Association; American Society for Public Administration, Association of Consulting Management Engineers, International City Managers Association, Life Office Management Association, National Office Management Association, Society for Advancement of Management, 54 business organizations, and 6 educational institutions.

It is estimated that approximately 240,000 persons interested in the techniques of scientific management contribute to the work of CIOS through its 15,000 affiliated member-organizations of national committees, and 170 constituent and associated organizations of its national councils.

Standards in Australia

AUSTRALIAN industry for more than 25 years has been saving millions of dollars because of the highly developed standardization machinery sponsored by industry and supported by the Australian government. Organized in 1922 four years after American engineering societies laid the groundwork for the American Standards Association, its American counterpart, the Standards Association of Australia with headquarters in Sydney has promulgated more than 750 standards covering construction, mechanical and electrical engineering, transportation, ferrous and nonferrous metals, mining and agriculture, and others. It was the first standards body in the British Commonwealth of Nations to introduce standards dealing with procedure and practice. More than 4500 individuals organized in over 500 committees carry on the work of the Association on a voluntary basis.

Sole executive authority of the Association is vested in a council on which Australian industry is fully represented, together with official representatives of the federal and state governments and all scientific, professional and commercial organizations.

The Association's financial support comes not only from member subscriptions and sales of publications, which provide the main support of the ASA, but also from a subsidy provided by the federal government and grants from state governments, Australian railway systems, and public utilities.

One of the earliest and classic examples of standardization in Australia was the specification for Portland cement. Before the standard specification was produced, manufacturers were called upon to supply cement to 26 different specifications. When a standard specification produced by the Association's Committee was adopted, the process was simplified by bulk manufacture with the resultant reduction in costs.

In 1947 standardization of check forms was adopted by all the Australian banks.

Meetings of Other Societies

Sept. 12–16
Instrument Society of America, national conference and exhibit, Municipal Auditorium, St. Louis, Mo.

Sept. 19–23
Illuminating Engineering Society, national technical conference, French Lick Springs Hotel, French Lick Springs, Ind.

Oct. 3–6
Association of Iron and Steel Engineers, annual convention, Hotel William Penn, Pittsburgh, Pa.

Oct. 6–7
Pennsylvania Electric Association, Prime Movers Committee, fall meeting, Hotel Edison, Sunbury, Pa.

Oct. 11–14
American Standards Association, Inc., annual meeting, Waldorf-Astoria Hotel, New York, N. Y.

Oct. 17–21
American Institute of Electrical Engineers, Midwest general meeting, Netherland Plaza Hotel, Cincinnati, Ohio

Oct. 17–21
American Society for Metals, national metal congress, Hotel Statler, Cleveland, Ohio

Oct. 18–22
National Safety Council, Inc., national safety congress, Stevens Hotel, Chicago, Ill.

Oct. 24–29
American Welding Society, 29th annual meeting, Bellevue-Stratford Hotel, Philadelphia, Pa.

(*For ASME Calendar of Coming Events see page 790*)

Codes and Standards

Public Comment Invited on Proposed ASA Elevator Code Revision

THE Sectional Committee of the Safety Code for Elevators sponsored by The American Society of Mechanical Engineers under the procedures of the American Standards Association, announces the following proposed revisions to Part V and Rule 201 of the American Standard Safety Code for Elevators, Dumbwaiters, and Escalators.

Constructive comment will be welcomed by the Committee.

Escalators

The tentative draft of the proposed revision of part V captioned "Escalators" of the American Standard Safety Code for Elevators, Dumbwaiters, and Escalators, covering Moving Stairways, has been completed and is now being distributed to the public for review and comments.

This draft is in general an amplification of part V of the present code. The caption has been tentatively changed to read "Moving Stairways" pending the outcome of a controversy concerning the use of these terms. The new revision contains detailed specifications relative to design dimensions and clearances of tread slots and comb plates, and clearances between steps, and between steps and balustrading. Factors of safety have been added to be used in design. Required safety devices have been clarified, as have the test specifications.

Glass panels are permitted in balustrading if made of tempered glass. The requirements for handrails have been revised to require the extension of the moving handrails beyond the line of the comb plates. Requirements have been added for guards at the intersection of the outside balustrade and the ceiling or soffit. Requirements for the use of incombustible material for step frames and treads have been added. Limiting dimensions have been added for the depth of step treads and for the rise between treads. Stairway speeds are limited to 125 fpm, but higher speeds are permitted subject to the approval of the administrative authorities. Minimum requirements have been added for the illumination of the step treads.

Buffers

The tentative draft of a proposed revision of Rule 201 of the American Standard Safety Code for Elevators, Dumbwaiters, and Escalators, covering car and counterweight buffers, has been completed and is now being distributed to the public for review and comments.

The revised draft differs from the present code in several important features. Solid buffers of resilient material are now permitted on low-speed elevators. Structural specifications are included for spring buffers, which do not appear in the present code. Data plates are now required to be attached to oil and spring buffers. Minimum specifications for buffer oils have been added. The required stroke of oil buffers is now based upon 115 per cent of contract speed rather than on governor tripping speed. Revised test specifications for the approval of oil buffers will appear in an appendix to the code (not available at present). The requirements for field testing to secure approval of oil buffers, and the rule covering the amount which oil buffers may be compressed when the car is level with its lowest landing, have been revised.

The complete text of the proposed revisions of Part V and Rule 201 may be obtained by writing to the Standards Department, The American Society of Mechanical Engineers, 29 West 39th Street, New York 18, New York. The Sectional Committee will welcome constructive comments.

ASA 1949 Standards

MORE than 140 new American Standards, approved since January of this year, are included in the midyear list of standards and special publications just issued by the American Standards Association. The list shows a total of 1124 standard specifications, methods of test, building requirements, dimensions, safety codes, definitions, and terminology in all fields of engineering as well as for materials and equipment used by the ultimate consumer.

All of these have been given the status "American Standard" through the procedure of the Association which assures all groups concerned an opportunity to have a voice in their development.

Important new standards listed for the first time include two American Standards in the series on small tools and machine tool elements, and a recently completed American Standard Plumbing Code, published by The American Society of Mechanical Engineers.

The 28-page list (July, 1949) can be obtained from the American Standards Association, 70 East 45th Street, New York 17, N. Y.

Reamers

A REVISION to the 1941 "American Standard on Reamers" has just been published by The American Society of Mechanical Engineers. The new 46-page standard is the work of the following sponsoring agencies organized under the procedures of the American Standards Association: Metal Cutting Tool Institute, Society of Automotive Engineers, National Machine Tool Builders' Association, and the ASME.

The revised standard provides general dimensions of 30 types of reamers and related tools, including magnitude and direction of tolerances and number of flutes. In bringing the 1941 issue up to date, several obsolete sizes were eliminated, and some new ones added. The standard contains 2 pages of terminology and definitions, and includes data on straight and taper shank arbors for shell reamers, and on arbor driving slots and lugs. The standard is available at the ASME Publication-Sales Department, 29 West 39th Street, New York 18, N. Y. Price is $1.

Steam Engines

THE 1949 issue of the "Test Code for Reciprocating Steam Engines" was recently published by The American Society of Mechanical Engineers. The code, first published in 1915, has undergone continual revision, the last one being in 1935. In accordance with Society policy to review periodically its codes and standards, Committee No. 5 on Reciprocating Steam Engines, under chairmanship of Alexander G. Christie, professor of mechanical engineering, The Johns Hopkins University, Baltimore, Maryland, checked the 1935 code, and upon decision that it still represented best test practice for this particular type of machinery, requested reissue of the code after references had been checked and brought up to date. The 28-page code discusses all factors pertaining to test procedures, and contains a table to serve as the form for report of tests. The code can be obtained from ASME Publication-Sales Department, 29 West 39th Street, New York 18, N. Y. Price is 80 cents.

Plumbing Symbols

MORE than 200 companies and individuals representing all branches of the plumbing industry have contributed to the new American Standard, "Graphical Symbols for Plumbing, ASA Z32.2.2-1949" recently published by The American Society of Mechanical Engineers.

The 9-page standard is one of a group which will ultimately replace the 1941 "American Standard Graphical Symbols for Use on Drawings in Mechanical Engineering," and replaces pages 3 through 5 of the 1941 standard.

Architects, engineers and plumbing contractors should find the use of the 73 symbols recommended for plumbing fixtures and allied items an aid in ending confusion in interpretation of requirements of contracts.

Copies may be obtained from the ASME Publication-Sales Department, 29 West 39th Street, New York 18, N. Y. Price is 40 cents.

British Steel Standards

A COMPILATION of engineering standards and practices of the British steel and steel products industry has recently been published by the British Standards Institution. As a project of the British steel industry, the 676-page handbook is divided into three parts. The first part describes the manufacture of steel and steel products. The second classifies and summarizes essential requirements of British standards used by the industry. The

third part presents information of general interest such as methods of test, heat-treatment, definitions, and conversion factors. Copies may be obtained from the British Standards Institution, 28 Victoria Street, Westminster, London S.W.1, England. Price is approximately $5.

Structural Analysis

A NEW American Standard, "Letter Symbols for Structural Analysis" (ASA Z10.8-1949) was recently published by The American Society of Mechanical Engineers. The 7-page standard, which is the work of the Sectional Committee on Letter Symbols and Abbreviations for Science and Engineering, covers general principles of letter-symbol standardization, and recommends use of 78 symbols in structural-analysis work. Copies may be obtained from ASME Publication-Sales Department, 29 West 39th Street, New York 18, N. Y. The price is 35 cents.

Education

MORE co-operation between British industry and the engineering schools was recommended in a recent study on education and training of "technologists" sponsored by the Federation of British Industries. The report defines technologists as "scientists who have also studied the application of the results of scientific knowledge and discovery to industry and the arts."

Among the eleven recommendations made were: (1) Industry and the schools working together should determine the balance between education, training, and experience required to develop a technologist; (2) better liaison between industry and schools to facilitate exchange of staffs for periods up to twelve months; and (3) more attention by the schools to the "development of the capacity for lucid exposition in the written and spoken word."

* * *

A NEW course in industrial hygiene will be offered co-operatively by the College of Engineering and the Institute of Industrial Medicine of the New York University-Bellevue Medical Center, beginning Sept. 26, 1949, to meet the growing demand for professional workers trained in the techniques of industrial hygiene. It will be open to physicians and to engineers holding bachelor degrees in sanitary, chemical, mechanical, or civil engineering, or having the equivalent training in the natural sciences, including chemistry and biology.

At the beginning of the course, physicians and engineers will attend the same classes and will study industrial medical practice, biostatistics, environmental conditions in work places and their relationship to disease, toxicology, and industrial physiology. Following this, the physicians and engineers will be separated, and the doctors will study industrial medical practice, occupational diseases, toxicology, and in-plant training, while the engineers will concentrate on environmental conditions and their control, and in-plant training.

The new course will embrace nine months of didactic teaching and three months of in-plant work. The tuition fee will be $600, plus registration. Further information may be obtained from The Dean, New York University College of Engineering, Bronx 53, New York, N. Y.

* * *

CENTER for Continuation Study, University of Minnesota, Minneapolis, Minn., announced the Second Midwestern Institute in Rail Transportation will be held from Sept. 26 to Oct. 8, 1949. The institute will be given by the University in co-operation with the Association of American Railroads, Association of Western Railroads, and Association of Rail Transportation Institutes.

The objectives of the institute are: (1) To give present and prospective executives in all fields of rail transportation a broad knowledge of the nation's rail and general transportation systems and their current problems, with emphasis on the competitive position of each type of carrier, and (2) to give the students working in the narrow field of an individual department an over-all view of the industry.

Further information regarding the institute can be obtained by communication with the Director, Center for Continuation Study, University of Minnesota, Minneapolis 14, Minn.

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H. E. MAYROSE, Mem. ASME, professor, department of engineering mechanics; K. E. Smith, professor, department of aeronautical engineering; J. J. Uicker, Mem. ASME, professor, department of mechanical engineering; and C. G. Duncombe, professor, department of chemical engineering, were named members of a special Engineering Research Council which has been established at the University of Detroit (Mich.).

After two years of planning by a special committee, the council has been formulated to co-ordinate the equipment and facilities of the University, it was reported by Dean Clement J. Freund.

"Research problems frequently involve many branches of science and varieties of apparatus, and require the efforts of several departments working together as a team. It is the function of the Research Council to unify these efforts," said the dean in his announcement.

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THE AMERICAN Academy of Arts and Sciences announced recently that income from its Permanent Science Fund will be disbursed as grants-in-aid in support of research projects in the fields of scientific business management, manufacture and commerce, engineering, mathematics, physics, chemistry, and other fields.

Applications for grants-in-aid are considered by the Committee on October 1 and March 1. Requests for information about conditions governing the grants should be addressed to: Hudson Hoagland, chairman, Permanent Science Fund Committee, Worcester Foundation for Experimental Biology, 222 Maple Avenue, Shrewsbury, Mass.

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R. P. HOELSCHER, Mem. ASME, who has been in charge of the College of Engineering Sciences at the University of Illinois Chicago Undergraduate Division since it was established in October, 1946, will return to the Urbana campus of the University of Illinois as head of the department of general engineering drawing. Frederick W. Trezise, who has been chairman of the division of engineering sciences at the University of Illinois division in Galesburg, Ill., will succeed Dean Hoelscher as head of the College.

Notes on Coming Meetings

Chemical Industries

CHEMICAL Industries' 22nd exposition will be held in Grand Central Palace, New York, N. Y., Nov. 28 to Dec. 3, 1949. Organization of the exposition has been completed on a scale rivaling any previous enterprise of its kind. Exhibits will be composed of raw materials, machinery, and products covering every recognized industrial and commercial application of chemical materials from medicinal preparations and foodstuffs to such important manufactures as paper, plastics, dyes, and many more.

Capital expenditures for chemicals and oils for new plants and equipment have been estimated to represent one fourth of the outlay by all industries during the current year, with one and a quarter billion going into new plants and equipment.

Irreversible Processes

THE Division of Fluid Dynamics of the American Physical Society will conduct, a three-day symposium on the subject, "Irreversible Processes in Fluid Dynamics," at the University of Virginia, Charlottesville, Va., on Dec. 28, 29, and 30. The sessions will be devoted to the following topics: energy transport and exchange, viscous and plastic flows, mass transport and fluctuation, entropy changes in irreversible processes, and energy transfers in shock, flame, and detonation fronts.

Requests for accommodations by nonmembers of the section should be sent to the Secretary, School of Physics, Rouss Physical Laboratory, University of Virginia, Charlottesville, Va., as soon as possible.

Management

"COMPETITION: The Challenge of the 50's" will be the theme of the 1949 annual conference of the Society for Advancement of Management which will be held Nov. 3 and 4 at the Hotel Statler, New York, N. Y. Emphasis will be on the ABC's of competition —active co-operation in building productivity and cutting costs.

Harold F. Smiddy, Mem. ASME, vice-president of the General Electric Company, is listed among the many outstanding speakers scheduled to address the conference.

Standardization

KARL T. COMPTON, Mem. ASME, chairman, Massachusetts Institute of Technology, and chairman, Research and Development Board of the National Military Establishment will address the 31st annual meeting of the American Standards Association at a luncheon to be held Oct. 14, at the Waldorf-Astoria Hotel, New York, N. Y.

Tentative plans for Thursday afternoon, Oct. 13, third day of the four-day series of conferences, have been made to hear reports on international developments in standardization by representatives of the American delegation who attended the summer meetings of the International Organization for Standardization in Paris.

Plant Maintenance

PLANT Maintenance Show and Conference, the first in the field, will be held in the Auditorium, Cleveland, Ohio, Jan. 16–19, 1950. L. C. Morrow, Mem. ASME, editor, *Factory Management and Maintenance*, will serve as general chairman of the fifteen-man advisory board of leading industrialists and editors as well as of the four-day conference on plant-maintenance methods which will be held concurrently with the show.

Some fifty companies already have reserved space and it is expected that several times that number will be represented when the show opens in January. The conference will be the first ever devoted exclusively to maintenance problems.

Major stress at both the show and conference will be placed on cost-reduction factors. Equipment, services, and materials to be exhibited will include the fields of air conditioning, heating, ventilating, buildings, building materials and services, maintenance tools and supplies, electrical equipment, employee relations, training and safety, instruments, meters, gages, lubricants and lubricating equipment, management consultants and services, materials-handling equipment, mechanical rubber goods, paints, painting equipment and product finishes, power generation and distribution, power transmission, and welding and gas cutting.

Hydraulics

TENTATIVE program for the fifth annual National Conference on Industrial Hydraulics to be held at the Sheraton Hotel, Chicago, Ill., Oct. 26–27, 1949, was announced recently. Eleven papers are listed on the following topics: Hydraulics in earth-moving equipment, positive-displacement rotary-piston power converter, large hydraulic valves, theory of hydraulic packings, hydraulic fluids, mechanics of fluid mixing, hydraulic tracer devices used in machine tools, and others. Two luncheons and a banquet will complete the program.

People

W. JULIAN KING, Mem. ASME, Melville Medalist, 1945, has resigned as director of Sibley School of Mechanical Engineering, Cornell University, to become professor of engineering at the University of California at Los Angeles. Professor King's new appointment will enable him to devote full attention to teaching and research. He is widely known for a series of articles, "The Unwritten Laws of Engineering," for which he received the Melville Award in 1945. The demand for reprints of the series broke ASME records.

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JAMES G. MORROW, metallurgical engineer, The Steel Company of Canada, Ltd., Hamilton, Ontario, was elected president of the American Society for Testing Materials for 1949–1950. Also elected were: Frank E. Richart, research professor of engineering materials, University of Illinois, Urbana, Ill., vice-president; the new members of the board of directors are as follows: R. D. Bonney, assistant manager of manufacturing, Congoleum-Nairn, Kearny, N. J.; C. H. Fellows, head, chemical division, research department, The Detroit Edison Company, Detroit, Mich.; H. F. Gonnerman, assistant to vice-president for research and development, Portland Cement Association, Chicago, Ill.; N. L. Mochel, manager, metallurgical engineering, Westinghouse Electric Corporation, Philadelphia, Pa.; and M. O. Withey, dean of engineering, University of Wisconsin, Madison, Wis.

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E. G. BAILEY AND R. M. GATES are serving as representatives of The American Society of Mechanical Engineers at the United Nations Scientific Conference on Conservation and Utilization of Resources which is being held at Lake Success, N. Y., Aug. 17–Sept. 6, 1949. E. A. Pratt is representing the Engineers Joint Council.

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H. MCKINLEY CONWAY, JR., was named recently director of the Southern Association of Science and Industry, Atlanta, Ga., a regional nonprofit, nonpolitical organization devoted to promotion of industrial research as a solution to Southern economic problems.

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JOHN S. BAER, student ASME, a senior in the department of mechanical engineering at Iowa State College, won the $250 third award of The James F. Lincoln Arc Welding Foundation, Cleveland, Ohio, for his paper entitled, "The Design of an Arc-Welded Forming Die."

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MALCOLM PIRNIE, consulting engineer, New York, N. Y., was made an honorary member of The Engineering Institute of Canada, it was announced at the sixty-third annual general meeting. Other awards were: Sir John Kennedy Medal to T. H. Hogg, York Mills, Ontario; Julian C. Smith Medal to R. W. Diamond, Trail, B. C.; Gzowski Medal to A. H. Wilson, Busby, Trail, B. C.; Leonard Medal to P. T. Bloomer, Kimberley, B. C.; Plummer Medal to C. O. P. Klotz, Montreal; Keefer Medal to J. D. Mollard, Regina, Sask.; and Ross Medal to B. G. Ballard, Ottawa, Ont.

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J. M. TODD, president, ASME, with the president of the National Safety Council, the Governor of New Jersey, and an officer of the New Jersey Safety Council will act as a committee of judges for the newly inaugurated Thomas Roy Jones Award, to go to voluntary associations and organizations in New Jersey which conduct the most effective statewide safety education program each year.

* * *

EDGAR C. BAIN, vice-president, Carnegie-Illinois Steel Company, will receive the 1949 Gold Medal of the American Society for Metals in recognition of his great versatility in applying science to the metal industry. The medal will be presented during the annual dinner of the society to be held in the Hotel Statler, Cleveland, Ohio, Oct. 20, during the 31st National Metal Congress and Exposition.

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HAROLD V. COES, Fellow ASME, past-president, ASME, now on the Economic Cooperation Administration staff in Paris, Theodor von Kármán, ASME Medalist, 1941, John Fritz Medalist, 1949; and Karl Terzaghi, consulting engineer, representing the U. S., attended a three-day meeting of experts in the engineering sciences held at UNESCO House, Paris, July 11–13.

The group, the first of its kind sponsored by UNESCO, was called together to coordinate the work of the engineering sciences and to give UNESCO advice in that field. The engineering sciences as applied to world problems of food and health were given special consideration, and methods for bettering the exchange of information pertaining to them were discussed with representatives of Food and Agricultural Organization and World Health Organization.

Mr. Coes reported that the French Union of Industrial and Professional Associations had tendered him and Mrs. Coes a formal reception.

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ARTHUR E. FOCKE, research metallurgist, Diamond Chain Company, Indianapolis, Ind., was elected president of the American Society for Metals. Also elected was Walter E. Jominy, staff engineer, Chrysler Corporation, to the office of vice-president.

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JOHN VAN BRUNT, Fellow ASME, vice-president of Combustion Engineering-Superheater, Inc., for more than a quarter of a century, and since Jan. 1, 1949, engineering consultant for Combustion Engineering-Superheater, Inc., was honored recently with the degree of doctor of engineering by Stevens Institute of Technology, Hoboken, N. J., at its 1949 commencement exercises. Mr. Van Brunt was a graduate of Stevens, class of 1897.

ASME NEWS

Something Is in the Wind!

BY THE time the weather recovers from its mania for record-breaking temperatures, the rumors of a meandering Gulf Stream, porpoises in the Hudson cutting capers, and royal palms along the Battery are finally put to rest, one of the first reassuring signs of sanity in the world may be the splendid fall series of engineering meetings worked up by the program-making agencies of The American Society of Mechanical Engineers.

No matter in what field one's personal interest lies, there is enough stimulating fare in the six major national events beginning with the conference of the Industrial Instruments and Regulators Division, to make life worth living again. Following one another like links of a chain are the Wood Industries Division Conference, the Fall Meeting, the conference of the Petroleum and Fuels Divisions, and finally the 1949 Annual Meeting.

1949 Annual Meeting

But if you are a one-meeting-per-year man, there are many reasons why that meeting should be the Annual Meeting. It is here that the Society can be seen as a living organism, conscious of its place in the scheme of American industrial life. If only to see the men whose thinking is molding the future of engineering thought, the expense is worth it. To participate in, or merely to listen to, the discussion of some original work can pay off handsomely. One idea stimulates another. In such an atmosphere one man's vehement protest to a statement of alleged fact, may open doors in one intuitive flash, to solutions of problems frustrating progress in work remotely concerned with the matter under discussion. In a sense, such a meeting, aside from the stimulation that comes from intercourse with people, becomes a free market of ideas, in which one can move from one stall to another, and take away free knowledge of experiences and ideas, whose actual worth is labeled by recitations of success or failure in specific applications.

Another derivative of the Annual Meeting is the sense of appraisal it provides for the professional engineer, a sense of where he stands in relation to the world about him, and apart from the intense specialization of his immediate job. As a free agent, he has more to contribute than his talent, whittled and polished by the day-by-day mastery of obstacles thriving in the microcosm of his own specialty. Above and beyond his "bread and butter" interest, he is often quite unaware of his own potentialities.

What is said and done at the Annual Meeting is a good antidote to such self-imposed isolation. This year, the theme will be "The Engineer's Contribution to a Peaceful World." Come and hear such talk as is seldom heard between 9 and 5 in the normal habitat of the engineer. Lillian M. Gilbreth will sound the keynote. Others who will follow her at the technical sessions, luncheons, and dinners, will fill out the outline of the engineer who understands how his work affects the purchasing power of his wife's dollar, and senses the direction which engineering must take if his country is to maintain her industrial hegemony.

Last year, ASME leaders were heard and seen on the air, tilting with theological minds and winning laurels which may have raised many a nonengineering eyebrow Certainly what L. J. Fletcher and William L. Batt said during the Town Hall Meeting of the Air Broadcast of Nov. 30, 1948, was an expression of confidence and faith in the engineering contribution to human welfare. Every engineer should feel that same confidence and faith, and should be able to expound it to his neighbors with the same facility that he finds in standing by a conviction in engineering.

Fall Meeting

Standing out among the coming meetings is the 1949 Fall Meeting, to be held in Erie, Pa., Sept. 27–30. The tentative program, published on pages 699–702 of the August issue, lists 21 technical sessions and more than 30 papers covering the work in most of the Professional Divisions. No mean attraction is the panorama of American industry available at Erie. In a few days, within one community, the Erie meeting should provide more good ideas than one member can possibly use.

Wood Industries

Members of the Wood Industries Division, whose conference will be held in Jamestown, N. Y., on September 27, 1949, and precedes the Erie Meeting, find themselves in the enviable position of winning two prizes with one throw. Jamestown and Erie are but 50 miles apart, and a drive through western New York in late September is something to think about.

Instruments

Excellent liaison has been established between the ASME Industrial Instruments and Regulators Division and the Instrument Society of America, the big wheel behind the annual Instruments Conference and Exposition to be held at the Municipal Auditorium, Chicago, Ill., Sept. 12–16. The Division is sponsoring two technical sessions and a luncheon. The exposition alone which provides in a nutshell a good idea of the state of the instruments industry in the country, is worth the time and expense of a trip to Chicago. For the program see pages 701–702 of the August issue.

Petroleum

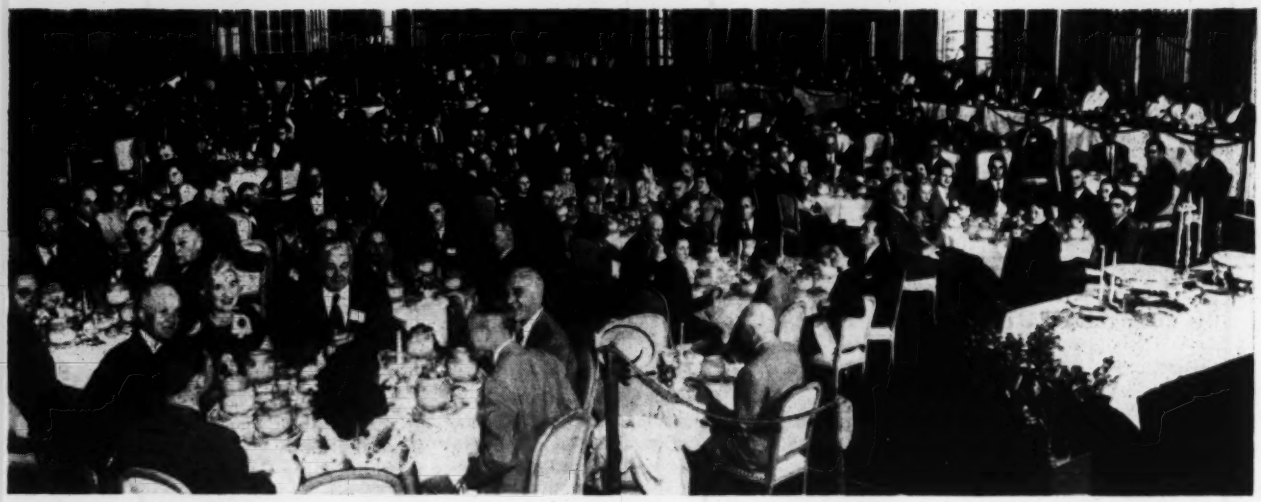
The Southwest again will be host to the ASME Petroleum Division whose annual conferences, inaugurated in 1946, have become a major engineering event in the petroleum industry. By directing its activities to the mechanical phases of the industry, the Petroleum Division is providing leadership in a branch of the industry not adequately covered by trade and professional agencies whose primary concern is with petroleum production and refining. For the tentative program and comment on the meeting to be held at Oklahoma City, Okla., Oct. 2–5, 1949, see pages 791–793 of this issue.

Fuels

The community of interest which exists among members of the ASME Fuels Division and the Coal Division of the American Institute of Mining and Metallurgical Engineers, one of the best harbingers of eventual unification of the engineering profession, has resulted in a long series of joint conferences. Known as National Fuels Conferences, the twelfth of the series will be held this year at the French Lick Springs Hotel, French Lick Springs, Ind.

AT THE SEMI-ANNUAL MEETING BANQUET

(*Left to right:* C. E. Davies, Secretary, ASME; Robert G. Sproul, President, University of California, James M. Todd, President, ASME; and Robert Sibley, Fellow ASME.)



BANQUET OF THE 1949 SEMI-ANNUAL MEETING, SAN FRANCISCO, CALIF., JUNE 27–30, 1949

1949 Semi-Annual Meeting Reflects Broad Interests of Engineers

AN excellent technical program of 60 papers presented before the Semi-Annual Meeting of The American Society of Mechanical Engineers held at the University of California Extension Building, San Francisco, Calif., June 27–July 1, 1949, focused the collective mind of 700 members and guests successively on problems of world scope and the industrial expansion of the West Coast, pin-pointed it on specific engineering developments, and carried it into the intangibles of engineering education and how the mind of the young engineer was influenced to cope with the potentialities of the atomic age. The intellectual breadth of the program, if it did not astonish some of the nonengineering guests, at least led them to suspect that the mechanical engineer was not the recluse he is sometimes made out to be, abiding amid his cherished engineering lore, and shutting from himself the noise and tribulations of a world groping for knowledge of itself and the forces that shape its destiny.

A skillfully planned and expertly conducted series of social events reflected the charm and hospitality of members of the San Francisco Section who were in charge of local arrangements, provided moments of relaxation and good fellowship, and served to sustain interest in the technical program.

The Society is indebted to the University of California for the use of the Extension Building facilities which contributed immeasurably to the success of the meeting.

Digests of 11 Semi-Annual Meeting papers were published in the August, 1948, issue, and 12 others appear on pages 756–760 of this issue. Watch future issues for the remainding digests.

Scientific Revolution

Speaking at a World Panel discussion of the engineer's opportunity for service, John B. Condliffe, professor of economics, University of California, said that the attempt to help other peoples along the road to industrial efficiency is a "more important aspect of our foreign policy than the small size of the appropriation might indicate.

"The United States is bound to be interested in the remaining storehouses of these basic materials—Africa, Southeast Asia, the Near East, as well as Latin America," he said. "It is bound to seek trade with these areas and to seek the friendship of their peoples. If ever we are ringed about with regimented economies tied to a rival power system, both our prosperity and our security will be seriously threatened.

"American industry is going abroad on a scale never before known," he stated.

"Foreign enterprises range from the vast programs of oil companies to surveys undertaken on a fee basis. This is real economic development. It is a new phase of capitalist enterprise. I call it the scientific revolution, because it is the inevitable outgrowth of the tremendous acceleration of scientific research in recent years.

"This 'scientific revolution' could transform the pattern of world production more drastically than the application of steam power did in the industrial revolution," he asserted. "And since the United States is the industrial laboratory for the new world, other peoples necessarily must look to America for technical training and 'know-how.'

"Private industry is ready and able to pour capital and know-how into industrially underdeveloped areas," he said, "but we cannot transform such countries overnight into the American pattern. We have as much to learn as they have—of their needs, their aspirations, and their difficulties. If we pour loans and capital equipment into communities unprepared to handle them, we shall only invite trouble. The only program that will work is one of mutual aid and consultative co-operation."

Scholarships for Engineers

In the address at the Palace Hotel banquet, Robert Gordon Sproul, president of the University of California, discussed "The Engineer and the World Outlook in the Atomic Age." Dr. Sproul reviewed the present-day conflict of ideologies.

Dr. Sproul said that although the universities have problems of adequate financing of staffs and facilities, the student is an equally important factor if the disparity between knowledge available and knowledge applied in practical affairs of the world is not to continue.

". . . . Many who should go to college fail to do so because of personal or family problems," he asserted. "These problems are both economic and psychological. . . They tend to waste one of the greatest of our natural resources, a perishable resource, the undeveloped mental power of youth. But from whichever point of view we take, it is important that society take hand in encouraging the most promising young people from each age group, both financially and emotionally. This means, in general, making scholarships and fellowships available, which will recognize high achievement and great promise, and which will carry with them monetary awards in accord with the individual's need.

"Every university has scholarships made available by endowment-fund income or by current gifts and bequests. The University of California offers several hundred scholarships each year. But relative to the magnitude of the job to be done the amounts available are totally inadequate. It is my personal conviction that they will never be adequate until associations of college alumni, professional groups, and industrial organizations make it their business to provide scholarships and fellowships through annual membership subscription. I would include The American Society of Mechanical Engineers among the list of associations which should provide such scholarships, and preferably on an international or at least a Western Hemisphere basis. In fact I would list it as one of the organizations which is important enough to set an example for dozens of other societies

and associations. In other days guilds of master craftsmen assured themselves of perpetuation and assured the public of continuing high standards by an apprentice system. The apprentice system no longer exists in the professions and semiprofessions. It is time that scholarship programs took its place, and who but the engineers should set a standard to which lesser men may rally."

Western Resources

"The West can, and must, more fully develop its resources and absorb a larger portion of the nation's population," Rex L. Nicholson, president of the Pacific Tractor and Implement Company, Richmond, Calif., told the dinner session held at the Claremont Hotel, Berkeley, Calif., June 28, 1949.

"Forty per cent of the nation's land and 35 per cent of its natural resources are in the West," he said, "yet only 14 per cent of the American people live in this region.

"With so large a portion of the total area of the nation and with so great a percentage of its natural resources, the West not only can, but must, absorb a much larger portion of the nation's total population.

"The West," he said, "is America's last great agricultural and industrial frontier and as such offers opportunities for expansion and development in both fields. This expansion can be accomplished through conservation of natural resources, harnessing of water facilities, preservation of soil, reforestation of land, stock-piling of strategic metals, and processing of western raw materials in the West.

"Local processing of raw materials has been especially underdeveloped," he asserted. "For example, the West produces the major volume of beef cattle, yet does not manufacture leather goods," he said, adding that Southwestern states produce 90 per cent of the nation's long-stapled cotton, but there are no textile mills west of the Mississippi River. The West raises 90 per cent of the nation's wool production, he continued, but has no facilities large enough to process wool from even one of the large sheep ranches. And likewise, the Pacific Northwest, which has demonstrated that it can produce the finest-quality flax fiber in the world, has no flax-processing facilities.

Steam Power in California

Steam-power facilities are being expanded so rapidly in California that by 1951 almost half the state's power will be steam-generated. The ratio has been 25 per cent steam and 75 per cent hydroelectric power in northern California, and 33.2 per cent steam and 66.5 per cent hydroelectric power in southern California.

C. C. Whelchel and W. R. Johnson of the Pacific Gas and Electric Company and W. L. Chadwick of the Southern California Edison Company, who presented the papers, gave several reasons for the current emphasis on steam power.

A population increase of 47 per cent in southern California and 51 per cent in northern California since 1940 has made necessary the provision of additional power facilities. Since the more favorable water-power sites within economical transmission distance of cities already are developed, the logical alternative was to concentrate on development of steam power.

They also pointed out that technological improvements in steam-plant design, such as larger unit size and higher efficiency, have tended to reduce the relative cost of steam power, although high fuel costs have partially offset these savings. The over-all result of all these factors has been a gradual shifting of the economic steam-hydro ratio from 66 to 75 per cent hydroelectric, and 33 to 25 per cent steam power to nearly equal amounts of each.

Previously, steam power has been developed only to the extent necessary to provide a reserve of power for years when production of hydroelectric power drops.

The postwar expansion programs are expected to add 1,747,000 kw to the State's steam-power capacity by 1951. Of this amount 987,000 kw will be added to the power capacity of northern California, and 760,000 kw to southern California.

Education

Speaking at the session sponsored by the ASME Education Committee, L. M. K. Boelter, dean, College of Engineering, University of California at Los Angeles, said that the prime job of the engineering curriculum was to aid the student in the formulation of his experiences.

"Certain engineering experiences must also be provided to those students," he said, "who live in 'closed' environments and who are sluggish observers. Some rote training should be included; it serves as a basis of reasoning and experimentation." Facility in the native tongue, pictorial representation and mathematical or symbolic modes of expression and in the modes of analysis are positive requirements.

"Some experience in synthesis and the art of engineering appear to be a necessary part of the students' growth. Training for function is an essential ingredient in a unified curriculum. The final tests to be applied to a curriculum are: (1) The student must be able to perform required tasks for adequate compensation immediately upon graduation; (2) he must be able to make enlightened contributions to the profession as he grows; (3) professional stature should be exhibited within five to ten years after graduation; and (4) he must also in this period become a contributing citizen and a strong intellectual force in his community."

Instruments for Nuclear Power

Operation of the first nuclear power plant probably will be limited because of inadequate development of instruments that can be used in areas of intense radiation and high temperature, David Cochran and C. A. Hansen, Jr., General Electric Company engineers at the Knolls Atomic Power Laboratory, stated.

Instruments are needed in the plant for control and safety of plant operation; for observing the condition and behavior of the plant as its operation proceeds; and for monitoring radiation leakage in the plant to insure protection of operating personnel.

"The grave consequences of an uncontrolled nuclear reaction make it mandatory that instruments and controls function properly and dependably," the engineers asserted. "There is nothing about a nuclear reactor that corresponds to the safety valve of a steam boiler in the conventional power plant. The nuclear reactor has a definitely limited capacity for absorbing or dissipating extra energy, so there must never be a runaway condition of the nuclear reaction." Of course, no single instrument bears the entire responsibility for the safety of the plant, it was explained, but even with a multiplicity of detecting devices and pyramiding of safety controls, the continued operation of the plant depends on all of them working all of the time.

AT THE SEMI-ANNUAL MEETING DISCUSSION ON EDUCATION

(*Left to right:* L. M. K. Boelter, Mem. ASME, dean, College of Engineering, University of California, Los Angeles, Calif.; George L. Sullivan, Fellow ASME, College of Engineering, University of Santa Clara, Santa Clara, Calif.; and M. P. O'Brien, Mem. ASME, dean, College of Engineering, University of California, Berkeley, Calif.)

Nuclear Energy for Mobile Machines

"Nuclear energy probably never can be utilized to run automobiles or locomotives, but it can be used to propel large ships, submarines, and airplanes," Glenn T. Seaborg, member of the General Advisory Committee to the U. S. Atomic Energy Commission told the meeting. Dr. Seaborg is professor of chemistry at the University of California and co-discoverer of fissionable isotope plutonium-239 and uranium-233 and of plutonium (atomic number 94), americium (atomic number 95), and curium (atomic number 96).

"Because of bulky shielding requirements, atomic-energy plants will be best suited to stationary structures, at least at first, but it is quite possible that such machines can be developed for mobile units where limitations on space and weight are not too great.

"Problems that must be solved before atomic energy can be useful are *largely engineering*. The machines must run at high temperatures in order to extract the energy in useful form, and this means that there will be problems involving materials of construction. Construction materials also must be chosen from those whose neutron absorption is small and this limits the choice to uncommon substances.

"Adequate coolants which do not absorb neutrons must be found and a method for con

trol of the reaction must be assured. It will also be necessary for the chemists and chemical engineers to develop very efficient procedures to purify the plutonium and uranium and also to repurify these materials in order that the unburned fuel may be used again."

Small Plant Management

Many small manufacturing enterprises born of wartime and postwar shortages and prosperity have not yet stood the test of serious competition, Frank K. Shallenberger, associate professor of industrial management, Stanford University, told the management session on Thursday, June 30.

Basing his comment on "personal experience, interviews with operators of small plants, and observance of their problems and operating methods," Mr. Shallenberger had this to say:

"The effective management control of production, cost, quality, and stores are largely neglected in many small companies, apparently because of the production man's natural aversion to paper work.

"These controls are not luxuries for the small plant, but they should be 'tailor-made' and as simple as the situation permits.

"The techniques of production management have as their objective, the efficient planning, execution, and control of manufacturing activities. They are designed to make the production executive's job easier and more effective, to minimize the time spent in trouble shooting and expediting, to eliminate the wastes of spoilage, shutdowns, broken delivery promises, idle men and equipment, and general inefficiency. Much can and should be carried in the manager's or foreman's head, but the entire operation cannot be effectively managed in a hit-or-miss, rule-of-thumb hip-pocket manner," he said. "On the other hand, the small manufacturer should not encumber his operation with the control procedures and paper work of the large concern."

Plant Trips

The inspection trips conducted during the meeting were varied and interesting and contributed substantially to the success of the meeting.

Many of the members and guests took advantage of the opportunity to visit such outstanding industrial, government, and research organizations as the San Francisco Naval Shipyard, University of California Radiation Laboratory, United Air Lines Maintenance Base, NACA Ames Aeronautical Laboratory, and Pacific Gas and Electric Company's Station P.

The visitors to the Naval Shipyard were transported to the base by launch, thus enjoying a wonderful sightseeing trip on San Francisco Bay. Points of interest at the Navy's No. 1 Pacific repair facility included the world's largest crane and the new and modern ordnance shop.

The University of California Radiation Laboratory presented an integrated and informative program to the visitors. After a luncheon in the university cafeteria, laboratory personnel briefed the group on the principles of nuclear research and on the equipment to be seen at the laboratory. Approximately two hours were then spent in touring the laboratory and in inspecting the cyclotron, the synchrotron, and the linear accelerator.

The trip to NACA Ames Aeronautical Laboratory was excellently arranged and planned, and impressed the visiting group by the magnitude and complexity of aeronautical research. Well-informed guides conducted the group through stations on supersonic research, flight testing, and on a complete tour of the world's largest wind tunnel.

Members interested in the generation of power had the privilege of visiting the newest and largest steam-operated plant on the Pacific coast. The Pacific Gas and Electric Company welcomed the group to Station P near Hunter's Point. Points of interest included the many and varied automatic controls used to operate the huge power station and the excellent layout of the equipment.

Committees

Arrangements for the Meeting were made by the following committee chairmen: General, Walter H. Kassebohm; Finance, Robert Schlitzkus; Technical Events, Raymond C. Grassi; Meals and Entertainment, C. Purves-Smith; Plant Trips, Robert W. Roth; International Panel, Robert Sibley; Registration and Housing, John B. Link; Reception, Phillip R. Faymonville; Ladies, A. Hansen; Transportation, Harry J. Smith; Printing, Thaxter Andruss.

Applied Mechanics Division Holds Conference

THE 15th National Applied Mechanics Conference sponsored by the Applied Mechanics Division of The American Society of Mechanical Engineers was held at the University of Michigan, Ann Arbor, Mich., June 13–16, 1949. The meetings were held in the amphitheater of the Horace H. Rackham Building which is the center of the graduate school at the University of Michigan. This amphitheater seats approximately 250 people. The meeting of the Applied Mechanics Division was made doubly interesting by the fact that the American Mathematical Society held its third annual symposium on applied mathematics simultaneously on the campus. The subject of the third symposium was theory of elasticity. The conjunction of these two meetings both dealing with closely allied subject matter brought to the campus of the University of Michigan one of the most important groups of people interested in applied mechanics and mathematics. The two groups held a joint session on Wednesday, June 15.

Including the joint meeting with the American Mathematical Society, there were three morning and three afternoon sessions at which some 28 papers were presented. The subjects discussed included vibrations, impact, fluid flow, plasticity, stress analysis, and mathematical theory of elasticity.

About 210 registrants attended the meetings of the conference; approximately 135 registrants attended the symposium on applied mathematics. All the sessions of the conference were well attended. The lists of registrants of both meetings included most of the prominent men of applied mechanics and applied mathematics in the United States. The meeting took on an international aspect with the attendance of Sir Richard Southwell, Fellow, Royal Society, lately rector of the Imperial College of Science and Technology, London, England, who delivered an address at a joint session on "Plastic Strain in Systems of Plane Strain and of Plane Stress." This address centered around the application of his relaxation method to this difficult problem.

AT THE ASME APPLIED MECHANICS CONFERENCE HELD AT THE UNIVERSITY OF MICHIGAN ANN ARBOR, MICH., JUNE 13–16, 1949

(*Left to right:* Sir Richard V. Southwell, Fellow, Royal Society, formerly rector of the Imperial College of Science and Technology, London, England; J. Ormdnroyd, professor of engineering mechanics, University of Michigan; S. P. Timoshenko, director of the Institute of Engineering Mechanics, Leland Stanford University, Palo Alto, Calif.; Ruel V. Churchill, professor of mathematics, University of Michigan, chairman of the Committee on Program and Arrangements for the Third Symposium of the University of Michigan, June 14–16, 1949)

James Dalton Cunningham
Nominated for President

ASME OFFICERS *Nominated for* 1949-1950

DURING the Meeting of The American Society of Mechanical Engineers in San Francisco, Calif., June 27-July 1, 1949, James Dalton Cunningham, president of Republic Flow Meters Company, Chicago, Ill., was nominated by the National Nominating Committee for the office of President of the Society for the year 1949-1950.

Regional Vice-Presidents named by the Committee to serve two-year terms on the Council of the ASME were F. M. Gunby, Boston, Mass. (renomination); J. C. Reed, Lewisburg, Pa.; A. C. Pasini, Detroit, Mich.; and S. H. Graf, Corvallis, Ore.

Directors at Large named by the Committee to serve a four-year term on the Council were T. E. Purcell, Pittsburgh, Pa., and B. P. Graves, Providence, R.I.

Members of the Committee making the nominations were: T. A. Fearnside, Boston, Mass., representing Region I; H. R. Kessler, New York, N. Y., representing Region II; P. C. Osterman, Elizabeth, N. J., representing Region III; S. B. Earle, Clemson, S. C., representing Region IV; Tomlinson Fort, East Pittsburgh, Pa., representing Region V; W. H. Oldacre, Chicago, Ill., representing Region VI; B. G. Dick, Portland, Oreg., representing Region VII; A. A. Woodward, Denver, Colo., representing Region VIII.

Election of ASME officers for 1949-1950 will be held by letter ballot of the entire membership, closing September 27, 1949.

Biographical sketches of the nominees follow on the succeeding pages.

Nominated for President

James Dalton Cunningham

JAMES DALTON CUNNINGHAM, who has been nominated to serve for one year as President of The American Society of Mechanical Engineers, was born in Chicago, Ill., May 5, 1887. He was educated in that city, being graduated from Hyde Park High School in 1905.

Mr. Cunningham entered the employ of Armour and Company in 1905, and remained there until 1909 when he purchased an interest in the Clyde Machine Works of Chicago. In 1911 he left the latter company and incorporated the Steam Appliance Company which later became Republic Flow Meters Company, of which he is president.

In 1918 Mr. Cunningham joined the ASME as an associate member. He was made a member in 1921, and a Fellow in 1936. He was manager of the Society from 1929 to 1932, and vice-president from 1932 to 1934. He was secretary and then chairman of the Chicago Section, and served five years on the Committee on Local Sections, acting as chairman the fifth year.

His interest in educational work culminated in his appointment in 1932 as chairman of the Board of Trustees of the Armour Institute of Technology which merged with Lewis Institute in 1940, changing its name to Illinois Institute of Technology. Mr. Cunningham received the honorary degree of doctor of engineering from the Illinois Institute of Technology in 1944. He is a member of the Western Society of Engineers, member of the board of managers of Presbyterian Hospital; was past-president and is now a member of the Advisory Board of Illinois Manufacturers' Association, chairman of the Cook County Chapter of The National Foundation for Infantile Paralysis, Inc., and a director of the Blue Cross Plan for Hospital Care. He is a director of the following companies: Allis-Chalmers Manufacturing Company; Baltimore and Ohio Railroad Company; Belden Manufacturing Company; Lake Shore National Bank; Lumbermen's Mutual Casualty Company and Associated Companies; Public Service Company of Northern Illinois. Mr. Cunningham is also a member of the Chicago, Union League, Commercial, and Indian Hill Clubs.

Nominated for Regional Vice-Presidents

To Serve Two-Year Term

FRANK M. GUNBY

JOHN C. REED

Frank M. Gunby

FRANK M. GUNBY, who has been renominated from Region I to serve for two years as Regional Vice-President of The American Society of Mechanical Engineers was born in Charleston, S. C., in 1882. He was educated at Clemson Agricultural College, from which he received the degree of BS in 1902, and the honorary degree of ME in 1928.

Mr. Gunby served the Eagle and Phenix Mills in Georgia as draftsman and electrician until 1905, and since then continuously, except for the period of World War I he was employed by Dean & Main, Inc., of Boston, Mass. In the early years he acted in the capacity of electrical engineer but branched into general industrial work, designing plants, and making reports and appraisals for various kinds of industry and power situations. He has also done work in India, Argentina, Canada, and Mexico. At the present time Mr. Gunby is associate and director of Chas. T. Main, Inc. He enlisted and was commissioned in the National Guard in Georgia and Massachusetts 1902-1907.

During World War I he was colonel in charge of engineering of the construction division of the Army which was responsible for all war construction in continental United States. In World War II he handled for his firm the architect-engineer work on large projects for troop housing, Ordnance Department, Chemical Warfare Service, and Air Corps, principally under the Corps of Engineers.

Mr. Gunby became a member of the ASME in 1915. He served on various committees as a member of the Boston Section, and was chairman of the National Nominating Committee in 1927, and a member of the Medals Committee 1935-1938. He is also a member of the American Institute of Electrical Engineers, American Society of Civil Engineers, Society of American Military Engineers, a past-president of the Boston Society of Civil Engineers, past-chairman, Engineering Societies of New England, member of the National Association of Cotton Manufacturers, and American Institute of Consulting Engineers, and was representative on the American Engineering Council.

John Clifford Reed

JOHN CLIFFORD REED, who has been nominated from Region III to serve for two years as Regional Vice-President of The American Society of Mechanical Engineers, was born on July 12, 1904, in Wilmington, Ohio. He received the degree of BME from Ohio State University in 1928, the degree of MS from the University of Illinois in 1931, and an ME from Ohio State University in 1934.

In 1928 he was appointed assistant in mechanical engineering at the University of Illinois, and instructor in mechanical engineering in 1929. He became an associate professor at the same college in 1933 and continued there until 1938 when he was made head of the department at the Colorado School of Mines, Golden, Colo. In 1942 he was appointed professor of mechanical engineering and head of the mechanical-engineering department at Bucknell University, Lewisburg, Pa., which position he now holds.

Professor Reed was consultant for the Mountain States Engineering Service from 1941 to 1942; consultant for Bucknell Alumni Research Foundation, and also standardization engineer, Air Conditioning and Refrigerating Machine Association, Washington, D. C., from 1943 to 1946; acting superintendent of buildings and grounds, Bucknell University, 1944 to 1947; surplus property officer of the same university in 1946; accredited assistant, U. S. Office of Education, 1946.

In 1928 Professor Reed joined the ASME as a junior member, and was made a member in 1945. He was active in the work of the local sections and was honorary chairman of the student branches both at the Colorado School of Mines and at Bucknell University.

Professor Reed is also a member of Sigma Xi; American Society for Engineering Education; Pi Mu Epsilon; Omicron Delta Kappa; Theta Chi, and many other societies. He has contributed much to the literature in the field of hydraulics, refrigeration, and fluid mechanics. He is married and has one son.

A. C. PASINI

S. H. GRAF

Albert Carl Pasini

ALBERT CARL PASINI, who has been nominated from Region V to serve as Regional Vice-President of The American Society of Mechanical Engineers for two years, was born in Paterson, N. J., Feb. 9, 1900. In 1923 he received his BS degree in mechanical engineering from the University of Michigan. He is employed by The Detroit Edison Company and is one of the superintendents of the production department. In the Engineering Society of Detroit, he has served on the following committees: professional engineer registration, civic affairs, refresher course, nominating, program, social events, and has been chairman of the affiliate council, which is the co-ordinating agency for 35 societies and 20,000 engineers in the Detroit area. He also served on the Prime-Movers Committee in the Edison Electric Institute.

During World War II he was fuel engineer on the fuel-efficiency council for the Detroit area in the Solid Fuels Administration.

Mr. Pasini joined the ASME in 1931. He has been chairman, secretary, treasurer, and program committee chairman of the Detroit Section. He has also served the ASME in the capacity of chairman of the National Agenda Committee, and as representative of the Detroit Section on the Civic Affairs Committee and on the stationary Engineers Ordinance Licensing Committee. At present he is chairman of the National Membership Development Committee and member of the Board of Membership. In 1931 his paper on "Comparative Tests of Refractories in Service," was published in ASME Transactions, and in 1947 his paper on "A Method for Testing and Studying the Cost of Operation of Centrifugal Boiler Feed Pumps," was also published by the Society. A paper on "The Supervision of Turbine Performance" was published in *Electric Light and Power* in August, 1943.

Mr. Pasini lives in Detroit and is a registered professional engineer of Michigan. He is a member of Theta Chi fraternity and an honorary member of Pi Tau Sigma.

Samuel H. Graf

SAMUEL H. GRAF, who has been nominated from Region VII to serve for two years as Regional Vice-President of The American Society of Mechanical Engineers, was born in Portland, Oregon, Aug. 4, 1887. He received his BS in EE in 1907, EE in 1908, BS in ME, 1908, ME in 1909, and MS in EE in 1909, all from Oregon State College.

Since 1908 Professor Graf has been connected with Oregon State College. He started as an assistant in the mechanical-engineering department. After several years as instructor and assistant professor in mechanical and experimental engineering he was appointed head of the department of experimental engineering in 1912, and two years later, professor. From 1920 to 1934 he served as professor of mechanics and materials. He has also been director of engineering research, 1927 to 1944, and director of the Engineering Experiment Station, 1944 to the present. Since 1934 he has been professor of mechanical engineering and head of that department.

Professor Graf has had an active consulting practice, serving as research engineer for about four years with the Portland Gas and Coke Company, in research work in safety of appliances for the American Gas Association Testing Laboratory, and as research engineer with the Iron Fireman Manufacturing Company. He was consulting engineer from 1935 to 1937 for the Bonneville Power and Navigation Project, and has been a consulting engineer for the Willamette Valley Project since 1936. He spent one summer conducting comprehensive tests on four suction dredges operated by Port of Portland and was test engineer in sixteen trial trips of merchant vessels built in Portland, Oregon. He was a test engineer with the U. S. Shipping Board, Portland, Oregon, for one year.

Professor Graf served as a member of the State Board of Engineering Examiners 1927 to 1949, representing the field of mechanical engineering, and as president of the Board 1939 to 1949. He was director of the western zone of the National Council of State Boards of Engineering Examiners from 1934 to 1936. In 1936–1937 he was vice-president and in 1937–1938 he served as president of NCSBEE.

In addition to his many outside engineering connections he has worked on many and various problems in the testing laboratories of his own department at Oregon State College. These investigations and tests have included work on structural materials, highway materials, fuels, and lubricants. He has also been engaged as consultant on inventions and a wide variety of problems brought to the college for solution.

As faculty editor of *Oregon State Tehcnical Record* since the start of that publication, Professor Graf has contributed many semitechnical articles to its pages. He was co-author of the Gas Appliance Testing Code published by Pacific Gas Association, and editor of the "Gas Engineers' Handbook," a reference work of about 1000 pages, published in 1934 by McGraw-Hill Book Company, Inc., New York, N. Y.

Professor Graf joined the Society in 1912 and is a past-chairman of the Oregon Section of the ASME, past vice-president of the Northwestern Society of Highway Engineers, past-president of the Oregon Chapter of the American Society for Metals, and a member of the Pacific Coast Gas Association. He has served twice on the Nominating Committee of the ASME, and has been honorary chairman of the ASME student branch at Oregon State College. Professor Graf was manager of the ASME 1943–1945, and director at large 1945–1946. He is a registered professional engineer of Oregon, and a past-president of Corvallis Engineers Club.

Professor Graf belongs to the honorary fraternities of Tau Beta Pi, Sigma Tau, Pi Tau Sigma, Eta Kappa Nu, Sigma Xi, Sigma Pi Sigma, and Phi Kappa Phi.

Nominated for Directors at Large

To Serve Four-Year Terms

B. P. GRAVES

T. E. PURCELL

Benjamin P. Graves

BENJAMIN PARKER GRAVES, who has been nominated for the office of Director at Large of The American Society of Mechanical Engineers, to serve a four-year term, was educated in the public schools of Providence, R. I., the Rhode Island School of Design, and Brown University. He entered the employ of Brown and Sharpe Manufacturing Company, Providence, R. I., in 1905, as drafting-room apprentice, and in 1915 he was appointed milling-machine designer. Mr. Graves became director of design of his company in 1929, which position he holds today.

Many patents in the machine-tool field have been issued to Mr. Graves, and he has contributed numerous articles to mechanical magazines. He has also presented papers before various societies, and holds membership in the Society of Automotive Engineers, the Providence Engineering Society, and the Society for Experimental Stress Analysis.

Mr. Graves became a member of the ASME in 1923, and was elected a Fellow of the Society in 1946. His activities in ASME include: chairman, Technical Committee No. 3 on Machine Tapers; Sectional Committee and Standardization of Small Tools and Machine-Tool Elements; member of Advisory Committee of Machine Design Division; past-chairman of Committee on Student Talks, Machine Design Division; past chairman and one of the organizers of the Machine Design Division; member of Committee on Medals for five years; chairman, 1943, Nominating Committee, and member of various technical committees. He was the first chairman of the Committee on Electrical Standards of the National Machine Tool Builders Association, and served for three years. It was he who suggested the organization and formation of Electrical Standards for Machine Tools.

Thomas E. Purcell

THOMAS EDWARD PURCELL, who has been nominated for the office of Director at Large of The American Society of Mechanical Engineers, to serve a four-year term, was born in Rochester, N. Y., on October 25, 1889, and attended grade and high school in East Bloomfield, N. Y., and technical school in Buffalo, N. Y. He entered the test department of the General Electric Company, Schenectady, N. Y., in 1910, and while there assisted in the development of electric ship propulsion, particularly as adapted to the original installation, the U. S. S. *Collier-Jupiter*. In 1912 Mr. Purcell entered the engineering department of the New York district office of the General Electric Company, remaining there until early in 1917, when he entered the U. S. Army as a second lieutenant in the Coast Artillery Corps. In 1918 he was discharged from his commission in the Army by the Secretary of War, and then took up the duties of assistant turbine engineer at the Erie Works of the General Electric Company, Erie, Pa., where a large development for the production of steam-turbine propulsion equipment for the U. S. Navy destroyers was being undertaken. In 1919, when this work was completed, Mr. Purcell returned to the New York district engineering department of the General Electric Company, specializing in development of large turbogenerators. He remained there until 1923, when he was engaged by Dwight P. Robinson and Company, New York, N. Y., as a design engineer. In 1925 he went to Pittsburgh, Pa., as general superintendent of power stations of the Duquesne Light Company, and general superintendent of the Allegheny County Steam Heating Company.

Mr. Purcell became a member of the Society in 1933. He is at present finishing his term as vice-president of Region V, and is a member of the Subcommittee on Model Smoke Law and the Special Committee on Antipollution Regulations, Committee No. 6 on Steam Turbines of the Power Test Codes Committee, the Subcommittee on Care of Steam Boilers and Other Pressure Vessels of the Boiler Code Committee, ASME-EIC Joint Conference Committee, and is a member of the Steam Power Panel, ASTM-ASME Joint Research Committee on High Temperature.

Other technical organizations in which Mr. Purcell holds membership are: the Prime Movers Committee, Edison Electric Institute; vice-chairman of the Committee on Power Generation, Association of Edison Illuminating Companies; the Engineers' Society of Western Pennsylvania; the National District Heating Association of which he is a past-president; the Smoke Prevention Association of America, Inc.; and the Joint EEI-AEIC Committee on the Use of Metals at High Temperatures.

Mr. Purcell has written many technical articles on matters pertaining to the steam and electric utility fields, and has produced several inventions in those fields.

ASME 1950 Nominating Committee Organizes

SELECTED at the 1949 Semi-Annual Business Meeting of The American Society of Mechanical Engineers, San Francisco, Calif., June 28, 1949, the 1950 National Nominating Committee at its organization meeting chose W. H. Oldacre, D. A. Stuart Oil Company, 2727 South Troy Street, Chicago, Ill., as chairman, and Claude L. Huey, Babcock and Wilcox Company, 1604 Chandler Building, Atlanta, Ga., as secretary.

Plans were made for a preliminary meeting of the committee at the 1949 Annual Meeting, New York, N. Y., at which arrangements will be made as to time and location of the executive meeting for nomination of the Society Officers in 1950.

The 1950 National Nominating Committee is composed of the following:

REGION I: Zenas R. Bliss, division of engineering, Brown University, Providence, R. I.; Alfred J. Ferretti, *1st Alternate*, Northeastern University, 360 Huntington Ave., Boston 15, Mass.; Harry E. Harris, *2nd Alternate*, 229 Thorme Street, Bridgeport 6, Conn.; Charles H. Coogan, Jr., *3rd Alternate*, mechanical engineering department, The University of Connecticut, Storrs, Conn.

REGION II: V. Weaver Smith, The Lummus Company, 420 Lexington Ave., New York 17, N.Y.; Paul T. Onderdonk, *1st Alternate*, Consolidated Edison Company of New York, Inc., 4 Irving Place, New York 3, N. Y.; Kenneth J. Moser, *2nd Alternate*, Stevens Institute of Technology, Hudson St., Hoboken, N. J.

REGION III: Henry H. Snelling, Snelling and Hendricks, 900 F St., N. W., Washington 4, D. C.; William G. McLean, *1st Alternate*, department of mechanics, Lafayette College, Easton, Pa.; C. B. Campbell, *2nd Alternate*, steam division, Westinghouse Electric Corp., Lester Branch P. O., Philadelphia 13, Pa.

REGION IV: Claude L. Huey, Babcock and Wilcox Company, 1604 Chandler Bldg., Atlanta, Ga.; Ervin M. Williams, *1st Alternate*, Clinchfield Fuel Company, Box 410, Spartanburg, S. C.; J. Marshall Johnson, *2nd Alternate*, Tennessee Valley Authority, Power Bldg., Chattanooga, Tenn.

REGION V: John W. Brennan, Hydraulic Coupling Division, American Blower Corporation, 8111 Tireman Ave., Detroit 32, Mich.; F. F. Borries, *1st Alternate*, Westinghouse Electric Corporation, 207 W. 3rd Street, Cincinnati, Ohio; Cecil R. Davis, *2nd Alternate*, Davis Automatic Controls, Ltd., 5 Blackmore St., Toronto 5, Ont., Canada.

REGION VI: Wm. H. Oldacre, D. A. Stuart Oil Company, 2727 South Troy St., Chicago 23, Ill.; Harold A. Bolz, *1st Alternate*, general engineering department, Purdue University, Lafayette, Ind.; Robert T. Mees, *2nd Alternate*, research department, Caterpillar Tractor Company, Peoria 8, Ill.

REGION VII: J. Alan Campbell, Westinghouse Air Brake Company, 501 Matson Building, San Francisco 5, Calif.; R. Lannert Iglehart, *1st Alternate*, Shell Development Company, 4560 Horton Street, Emeryville 8, Calif.; Albert R. Weigel, *2nd Alternate*, Consolidated Western Steel Corporation, 5700 South Eastern Avenue, Los Angeles 54, Calif.

REGION VIII: Henry B. Atherton, Kansas City Power and Light Company, Postal Station "F," Kansas City 1, Mo.; Venton L. Doughtie, *1st Alternate*, The University of Texas, University Station, Austin 12, Texas; Glyn Beesley, *2nd Alternate*, Dallas Power Light Co., 1506 East Commerce, Dallas 1, Texas.

Finnish Student Wins Rice Award

RALPH Liljelund, Helsinki, Finland, graduate of the department of mechanical engineering, Finnish Technical University, and now a teacher at the University, is the recipient of the Calvin W. Rice Memorial Scholarship Award for 1949–1950 presented by the Woman's Auxiliary to The American Society of Mechanical Engineers. Mr. Liljelund was selected through the co-operation of the Institute of International Education, and with approval by the State Department.

Actions of the ASME Council

At Meetings in San Francisco, June 26 and 27

THE Council of The American Society of Mechanical Engineers met in three sessions during the Semi-Annual Meeting held in the University Extension Building, San Francisco, Calif., June 26 and 27, 1949. Those present at one or more of the sessions were: James M. Todd, president, E. G. Bailey, Eugene W. O'Brien, W. H. McBryde, and W. F. Durand, past-presidents; J. Calvin Brown, Paul B. Eaton, Carl J. Eckhardt, Frank M. Gunby, A. R. Mumford, Forrest Nagler, and Thomas E. Purcell, vice-presidents; J. B. Armitage, J. A. Keeth, James N. Landis, Abbott L. Penniman, Jr., and Ralph A. Sherman, directors at large; A. M. Gompf (Board on Membership), H. H. Snelling (Constitution and By-Laws Committee), A. C. Pasini (Membership Development Committee), F. F. Borries, T. A. Fearnside, H. R. Kessler (Nominating Committee), M. C. Abrahm, E. W. Allardt, W. L. Betts, E. R. Birkicht, W. H. Byrne, L. B. Cooper, R. E. Gallatin, F. V. Hartman, W. E. Hogan, E. W. Jacobson, J. A. Keene, J. H. Keyes, W. G. McLean, Rudolph Michel, M. E. Turner, E. H. Walton (Regional Delegates); Vernon McCloskey (student), Walter K. Morris, Robert F. Nadeau, J. E. O'Brien, junior observers; C. H. Shumaker, guest; C. E. Davies, secretary, Ernest Hartford, executive assistant secretary, and O. B. Schier, meetings manager.

Uniform Grades

Council noted a report that ECPD was preparing a statement of uniform grades and minimum qualifications for membership for consideration of its constituent societies. It was the consensus that the Society should take no action to adopt the suggested grades until such time as there was some assurance that other constituent societies were to take similar action.

Dues-Exempt Members

The Board on Membership presented for first reading a proposed amendment to Article B5, Par. 12 of the By-Laws regarding policy for dues-exempt members and a new Rule 3, Article R5 to be acted upon if the amendment is adopted. The amendment adds the phrase "and has notified the Society of his retirement" to the requirements for life membership for those members who have paid dues for 35 years or who have reached the age of 70 after having paid dues for 30 years.

Amendments

Two amendments to the By-Laws which received first reading at the 1948 Annual Meeting were adopted. The first amendment deletes Par. 14, Art. B6A and changes numbering of paragraphs 15 through 20-A to 14 through 19-A. The second directs the Society to designate representatives rather than a Standing Committee on Library to represent the Society on the Library Board of the United Engineering Trustees, Inc., according to the by-laws of that body.

Amendments to Rules 4, 7-11, article R 4 dealing with qualifications for admission, and Rule 4 Article R10 dealing with professional divisions and groups, were adopted.

Proposed amendment to Par. 17-B, Art. B6A which received first reading at the 1948 Annual Meeting, was referred back to Constitution and By-Laws Committee without action.

Nuclear Energy

An educational program prepared by the Nuclear Energy Application Committee to promote increased industrial activity in atomic energy work in co-operation with the Atomic Energy Commission, was approved for transmittal to David E. Lilienthal, chairman of the AEC.

Policy on Sub-Sections

The following statement was adopted as policy on formation of Sub-Sections:

1 In a Section which has a concentration of at least 50 members at a distance from the normal center of Section activities with sufficient leadership and interest to warrant meetings and related activities, a sub-section may be established upon recommendation of the Vice-President and with the approval of the Council after formal request is submitted showing the area to be included and the approval of leaders in the new sub-section and of the officers of the Section.

2 The following provisions shall guide the operations of Sub-Sections:

a The government of the Sub-Section shall be provided in the Section By-Laws which shall, among other matters, provide that the Sub-Section Chairman be a member of the Section Executive Committee.

b Sub-Sections will participate in community activities of engineers upon approval of the Section Executive Committee and in accord with the provisions of the Society By-Laws.

c Sub-Sections being a part of Sections will not be represented as such in Regional Administrative Committees but the officers of the Section will take steps to assure that the members in the Sub-Section and the officers are informed about the agenda and findings of the Regional Administrative Committee meetings.

d Normal annual formula support to the Sections shall be $150 for each Sub-Section. The Section Executive Committee shall allocate operating funds to the Sub-Section.

e The Section officers and the Vice-President shall review the activities of the Sub-Section annually and if in their judgment the character and extent of Sub-Sections' activities are not adequate, the Vice-President shall recommend to the Council the disbandment of the Sub-Sections.

Student Branches

With the approval of the Vice-Presidents, sale to students of student-member badges at $1 was approved. Heretofore badges were distributed free to student members.

Upon invitation from the American Society of Civil Engineers the Council authorized ASME participation in an intersociety committee whose objective will be a joint study of student branches to reduce confusion and duplication of effort detrimental to the best interests of engineering students. Nine other engineering societies sponsoring student branches have been invited to participate. The Council suggested that the EJC also take up this problem.

The National Committee on Relations with Colleges, authorized in June, 1946, was discontinued upon recommendations of the Vice-Presidents.

Graduating Veterans

The problem of graduating veterans whose age when applying for transfer to junior membership places them in the $15 or $20 dues classification, was discussed at length. It was the consensus that no formal action was required and that in case of hardship each applicant could be handled as an individual case under the By-Laws and Rules as they now exist.

Regional Delegates

The Council commended the regional delegates for their excellent and well-presented report. Council expressed its appreciation for the work done and referred recommendations to the committees involved.

Certificates of Award

Certificates of award were granted to the following past-chairmen of sections: Detroit Section: John W. Brennan; New Orleans Section: George R. Hammett, Lionel J. Cucullu, Arthur M. Hill, Edward A. McLellan, and Michael C. Abrahm.

Unity of Engineering Profession

An invitation from the Engineers Joint Council for the ASME to designate a representative to serve as a member of a group "to explore in a preliminary way the desirability and practicability of increased unity in the engineering profession and possible forms of organization which may be considered to bring this about" was discussed. The invitation was accepted and the President authorized to appoint an ASME representative to the proposed group.

Mrs. G. S. Wood

The Council noted with regret the death on June 18, 1949, of Mrs. Genevieve S. Wood who had been a loyal member of the staff for 28 years.

Appointments

The following appointments were approved by the Council:

W. F. Ryan, ASME representative on ECPD for a three-year term; W. H. Carson, L. J. Hughlett, R. E. W. Harrison, A. J. Ackerman, and Joseph Pope, honorary vice-presidents to represent the Society at the First Pan-American Engineering Congress, Brazil, July 15-24, 1949.

ASME Calendar

of Coming Events

Sept. 12–16

ASME Industrial Instruments and Regulators Division Conference and Exhibit, Municipal Auditorium, St. Louis, Mo.

Sept. 27

ASME Wood Industries Division Conference, Jamestown, N. Y.

Sept. 27–30

ASME Fall Meeting, The Lawrence Hotel, Erie, Pa.

Oct. 2–5

ASME Petroleum Division Conference, Oklahoma Biltmore Hotel, Oklahoma City, Okla.

(*Final date for submitting papers was June 1, 1949*)

Oct. 26–27

ASME Fuels Division Conference, French Lick Springs Hotel, French Lick Springs, Ind.

(*Final date for submitting papers was June 1, 1949*)

Nov. 27–Dec. 2

ASME Annual Meeting, Hotel Statler, New York, N. Y.

(*Final date for submitting papers was Aug. 1, 1949*)

April 12–14

ASME Spring Meeting, Hotel Statler, Washington, D. C.

(*Final date for submitting papers—Dec. 1, 1949*)

April 24–26

ASME Process Industries Division Conference, William Penn Hotel, Pittsburgh, Pa.

June 12–16

ASME Oil and Gas Power Division Conference, Lord Baltimore Hotel, Baltimore, Md.

June 12–16

ASME Fourth National Materials Handling Exposition and Conference, International-Amphitheater, Chicago, Ill.

June 19–23

ASME Semi-Annual Meeting, Hotel Statler, St. Louis, Mo.

(*Final date for submitting papers—Feb. 1, 1950*)

June 22–24

ASME Applied Mechanics Division Conference, Purdue University, Lafayette, Ind.

(*For Meetings of Other Societies see page 777*)

Policies on ASME Budget for 1949–1950

THE following statement of policies with the schedule of income and expense constitutes the Budget for 1949–1950.

1 A continuous effort will be made to collect dues by regular monthly billings. Quarterly payments will be accepted.

2 No appropriation shall be made by Council without first referring back to the Finance Committee for recommendation. When a liability is assumed the means for paying for it shall be provided in advance.

3 No new activity shall be undertaken without definitely showing that the funds required to support it will be available without decreasing the appropriations for existing essential activities, giving the consideration

COMBINED ANALYSIS OF EXPENDITURE BUDGET 1949–1950

	Under Committee Supervision			Printing and		
	Joint Bodies	Members Travel	Others	Distribution	Office Expense	Total
PUBLICATIONS, STANDARDS, CODES & RESEARCH						($556,485)
MECHANICAL ENGINEERING, text pages (excluding student copies)				$ 65,600	$ 27,895	93,495
MECHANICAL ENGINEERING, advertising pages (excluding student pages)				88,100	60,860	148,960
Transactions (including *Journal of Applied Mechanics*)			$ 1,100	9,200	17,705	28,005
Membership List				3,000		3,000
ASME Mechanical Catalog				49,000	41,840	90,840
Publication sales (except standards, codes, and research reports)				43,600	17,565	61,165
Standards and codes	$ 1,000			45,775	77,695	124,470
Research				3,000	3,550	6,550
GENERAL SOCIETY ACTIVITIES						($261,210)
Society meetings (including publicity)			23,000		17,480	($40,480)
Sections (including Regional Administrative Committees of Regional Delegates Conference)		$14,500	54,000		15,765	84,265
Professional divisions			7,000		15,730	22,730
Student Branches (including copies of MECHANICAL ENGINEERING text and advertising pages)		4,000	18,800	55,000	11,615	89,415
Admissions					18,710	18,710
Development					3,710	3,710
Awards			800		600	1,400
Engineers Civic Responsibility		500				500
GENERAL SOCIETY ADMINISTRATION						($40,500)
Council		4,800	1,500			6,300
Professional services (auditors, counsel, etc.)			3,000			3,000
Nominating Committee		2,000				2,000
Retirement Fund			28,700			28,700
"Know Your Society" (organization charts)			500			500
JOINT ACTIVITIES						($20,450)
Engineering Societies Library	$13,250					13,250
Engineers' Council for Professional Development	1,700					1,700
Engineers Joint Council	1,500					1,500
Engineering Societies Personnel Service, Inc. (reserve)	500					500
Registration (National Council of State Boards of Engineering Examiners)	500					500
UET pension fund	2,500					2,500
National Management Council	500					500
INDIRECT EXPENSE						($197,216)
Secretary's office					$ 42,670	42,670
Accounting department					38,940	38,940
General service (stores, mailing, filing, etc.)					72,830	72,830
General office (rent, insurance, etc.)					42,776	42,776
	$21,450	$25,800	$138,400	$362,275	$527,936	$1,075,861

to the administrative expense that may be involved. When a new activity is authorized if the additional funds to support it are not directly available from the unappropriated income, Council shall say what activity shall be curtailed or suppressed to permit transference of the fund required to support the new activity. If the budget of expenses is to be reduced, the Council shall say what activity shall be curtailed or suppressed.

4 The Society shall hold four general meetings with expense chargeable to the 1949-1950 budget. A fee shall be charged to nonmembers for admission to general or technical sessions at the four National Meetings of the Society. The amount of the fee shall be the same for attendance at one or all of the sessions at a meeting. If a nonmember is the author of a paper presented at a meeting or if he has been formally invited to discuss a paper, he shall be exempt from payment of the registration fee for that meeting. Non-engineer members of the immediate family of a member shall also be exempt from payment of the registration fee.

5 Council meetings shall be held at the place and time of the Annual and Semi-Annual Meetings in 1950. Council representation within the budget shall be provided for the other national meetings.

6 Within the allowance of the budget, Vice-Presidents shall be expected to visit Sections and Student Branches and attend Student Branch Conferences in their Regions or arrange for visits by their representatives.

7 No travel allowance will be provided for Board and Committee Chairmen attending Council meetings except upon special provision of Council or the Executive Committee.

8 Eight Regional Administrative Committee meetings will be held.

9 The Nominating Committee may hold a preliminary meeting at a place to be selected and a Selection meeting at the Semi-Annual Meeting within the provisions of the budget.

10 The following uniform basis of contribution toward travel expense shall be adopted:

5 cents per mile one way plus allowance of $3.50 per diem for time at the meeting not exceeding two days plus total traveling time by standard railroad route plus 50 per cent for the Council, 1949-1950 Nominating Committee, Regional Administrative Committees, Sections, and Regional Delegates. When Board and Committee Chairman are required to attend Council meetings, the same provisions will be made.

For Student Branch Conference—13¢ per mile for each Student Branch Delegation, including the honorary chairman. Student delegations under this provision may consist of (*a*) the honorary chairman, (*b*) the honorary chairman and at least one student-delegate, or (c) one or more student delegates.

Visits of President and Vice-Presidents or their designated representatives to Sections, Branches, etc.—out of pocket expense within budgetary limits prescribed.

11 The Society shall have two representatives on the American Standards Association.

12 No publications shall be printed for sale unless there is reasonable assurance of sufficient orders to pay for the cost.

BREAKDOWN OF ASME BUDGET—1949-1950

		Budget 1949-1950
MECHANICAL ENGINEERING and Mechanical Catalog income	$370,000.00	
less production costs, wages, and indirect	289,162.00	$ 80,838.00
General publication sales income	$ 74,750.00	
less stock costs, wages, and indirect	73,760.00	990.00
Engineering index		3,000.00
Miscellaneous sales		5,000.00
Interest and discount		19,000.00
Membership dues		438,260.00
TOTAL		$547,088.00
MECHANICAL ENGINEERING text (production, wages, and indirect)		$112,737.00
Transactions (production, wages, and indirect)		33,768.00
Membership list (production, wages, and indirect)		3,622.00
Standards and Codes (income)	$106,000.00	
Stock cost, wages, and indirect	148,537.00	42,537.00
Research (income)	$ 3,000.00	
Stock cost, wages, and indirect	7,939.00	4,939.00
Student dues	$ 57,000.00	
Student expense (production, wages, and indirect)	107,216.00	50,216.00
Meetings (income)	$ 2,000.00	
Meetings expense (costs, wages, and indirect)	48,087.00	46,087.00
Sections (appropriations, travel, wages, and indirect)		100,102.00
Divisions (appropriations, travel, wages, and indirect)		28,003.00
Admissions and development (wages and indirect)		26,628.00
Awards (costs, wages, and indirect)		1,662.00
Engineers Civic Responsibility		500.00
Joint activities		36,903.00
General administration		57,235.00
TOTAL		$544,939.00
NET INCOME		$ 2,149.00

ASME 1949 Petroleum Mechanical Engineering Conference

October 2–5, Oklahoma City, Okla.

THE 1949 Petroleum Mechanical Engineering Conference sponsored by the Petroleum Division of The American Society of Mechanical Engineers will be held at the Oklahoma Biltmore Hotel, Oklahoma City, Okla., Oct. 2-5, 1949.

Fourth Organized Conference

The conference will be the fourth organized by the ASME Petroleum Division. Recognized as one of the major annual engineering events of the petroleum industry, the conference is expected to bring together more than 500 engineers, research workers, and petroleum executives to discuss recent developments in the fields of petroleum production, refining, transportation, materials, and equipment.

While the conference will get under way officially with a luncheon, Monday, October 3, at which the Honorable Roy J. Turner, Governor of Oklahoma; will welcome the delegates, registration will begin Sunday afternoon, and social events have been planned for Sunday evening to provide both members and guests the opportunity to meet with one another.

Registration Fee

Members will be asked to pay a registration fee of $3.50 and nonmembers $5 to defray administration expenses and the cost of a proceedings packet containing preprints of approximately 27 conference papers which registrants will receive. Students and women guests will not be required to pay the registration fee.

The Middle East

Early registration is urged, if only to hear W. H. Carson, dean, college of engineering, University of Oklahoma, Norman, Okla., who has recently returned from the Second International Technical Congress held in Cairo this summer. Dean Carson, who attended the Congress as official delegate of the Engineers Joint Council, will report informally on experiences at Cairo, and give some insight into the political machinations permeating the international stage of engineering activity. Dean Carson will have something to say about

international engineering education, and will illustrate his talk with colored slides of scenes taken in Egypt, Lebanon, and Arabia.

Monday morning, October 3, will be devoted to administrative meetings of the ASME Petroleum Division.

Thirteen technical sessions compose the technical program during which 27 papers will be read on such subjects as development of unitized well-control manifolds, economic factors in sizing and selecting pipe-line field pumping units, application of gas turbines in refineries, flowmeter research, and others. The program will feature papers on coal hydrogenation. The subject will be introduced at the luncheon on Tuesday, when J. A. Markovits, who is assistant chief of the coal-to-oil demonstration branch of the office of synthetic-liquid fuel, Bureau of Mines, Louisiana, Mo., will describe the coal-hydrogenation demonstration plant, and comment briefly on the scope of several papers on various aspects of the subject scheduled for presentation later in the program. These papers will deal with design of high-pressure vessels for coal-hydrogenation service, piping, flanged joints, and fittings for 10,300-psi service; metallurgical and fabrication considerations, and design of preheaters and heat exchangers for coal hydrogenation.

Banquet

The social high light of the program will be the banquet on Tuesday. Stewart Harrel, director of public relations, University of Oklahoma, will speak on "Oil and the Mechanical Engineer." William Raisch, consulting engineer, New York, N. Y., and one of the organizers of the ASME Petroleum Division, will preside. Dean W. H. Carson will serve as toastmaster. President Todd will speak briefly.

Inspection Trips

Two interesting inspection trips have been arranged. The first, on Monday, will be to the Belle Isle Plant of the Oklahoma Gas and Electric Company to see operation of the first commercial installation of a gas turbine. The buses will leave headquarters hotel at 5:15 p.m. Following the inspection, the party will be taken to Belle Isle Park for a special dinner, and an evening of entertainment.

The second inspection trip, on Wednesday, will be to Tinker Air Field, where members will be guests of the U. S. Army Air Corps. Following an inspection of the jet-engine repair facilities at the airfield, members will enjoy a special air show of P-80 Shooting Stars as well as a flight of a B-36 bomber.

Women's Program

An interesting women's program has been arranged by the local Women's Entertainment Committee, under the chairmanship of Mrs. W. H. Stueve. The program will consist of a luncheon on Monday at the Oklahoma Biltmore Hotel, a luncheon and style show on Tuesday in the Empire Room of the Black Hotel, and will conclude with the fellowship party and banquet that evening.

The Tentative Program

SUNDAY, OCT. 2

3:00 p.m.

Registration

8:00 p.m.

Travelogue of the Middle East

W. H. Carson, dean, college of engineering, University of Oklahoma, Norman, Okla., will describe summer visits to the Near East and comment on international engineering activities. Colored slides of scenes of Egypt, Lebanon, and Arabia will illustrate his talk.

MONDAY, OCT. 3

12:00 noon

Welcome Luncheon

Chairman: W. H. Stueve, executive assistant, Oklahoma Gas and Electric Company, Oklahoma City, Okla.

Address of Welcome: Honorable Roy J. Turner, Governor of Oklahoma

Response: James M. Todd, president, ASME.

Address: Unusual Aspects of the Construction of Pipe Lines in the Middle East, by Burt E. Hull, president, Trans-Arabian Pipe Line Company, San Francisco, Calif.

Production

Development of Unitized Well Control Manifolds, by Marvin R. Jones, chief engineer, Oil Center Tool Company, Houston, Texas.

Pumping Well Studies, by D. O. Johnson, partner, Johnson-Fagg Engineering Company, Tulsa, Okla.

Transportation

A Pipe-Line Flow Controller For Partial Loops, by G. P. Jennings, chief engineer, products pipe-line department, Phillips Petroleum Company, Bartlesville, Okla.

Economic Factors to Be Considered in the Sizing and Selecting of Pipe Line Field Pumping Units, by G. L. Maciula, head of development section, Stanolind Pipe Line Company, Lubbock, Texas.

Turbocharging Experience of the Stanolind Pipe Line Company, by F. V. Cook, master mechanic, Stanolind Pipe Line Company, Tulsa, Okla.

Refining

Application of Gas Turbines in the Refinery, by C. F. Codrington, chief engineer, blower and condenser department, Allis-Chalmers Manufacturing Company, Milwaukee, Wis.

Characteristics of Diaphragm Motor Valves, by Thomas L. Smith, chief field engineer, Belfield division, Minneapolis-Honeywell Regulator Company, Houston, Texas.

5:15 p.m.

Inspection Trip

First commercial installation of a gas turbine at the Belle Isle plant of the Oklahoma Gas and Electric Company.

7:00 p.m.

Dinner and Entertainment

Belle Isle Park

TUESDAY, OCT. 4

9:15 a.m.

Production

Secondary Recovery Equipment Selection, by J. H. Field, chief production engineer for district, Sohio Petroleum Company, Oklahoma City, Okla., and E. N. Kemler, associate director, Southwest Research Institute, Houston, Texas.

Horizontal Treaters Versus Vertical Treaters, by A. W. Francis, Jr., assistant chief engineer, National Tank Company, Tulsa, Okla.

Transportation

The ASME and Flowmeter Research, by S. R. Beitler, professor of hydraulic engineering, Ohio State University, Columbus, Ohio.

Pressure Loss in Tubing, Pipe, and Fittings, by R. J. S. Pigott, director, engineering division, Gulf Research and Development Company, Pittsburgh, Pa.

Crude-Oil Flow Characteristics Experienced in Large-Diameter Lines, by Lowell E. Anderson, Jr., engineer, Stanolind Pipe Line Company, Tulsa, Okla.

Refining Materials

American Standard Steel Pipe Flanges—Their Development and Proper Usage, by J. D. Mattimore, chief engineer, Tube-Turns, Inc., Louisville, Ky.

Reports on the Behavior of Some Welds at Subzero Temperatures, by T. N. Armstrong, metallurgist, International Nickel Company, New York, N. Y.

12:15 p.m.

Coal-Hydrogenation Luncheon

Speaker: J. A. Markovits, assistant chief, Coal-to-Oil Demonstration Branch, Office of Synthetic Liquid Fuels, Bureau of Mines, Louisiana, Mo.

2:00 p.m.

Production Manufacturers

Diesel-Electric Drilling Rigs, by E. H. Lamberger, petroleum-industry engineer, Westinghouse Electric Corporation, East Pittsburgh, Pa.

Stage Separation, by G. O. Kimmell, vice-president, Kimray, Inc., Britton, Okla.

Transportation

Recent Trends in Transportation of Petroleum on the Mid-Western Rivers, by J. R. Shipley, chief engineer, transportation department, Sohio Petroleum Company, St. Louis, Mo.

Developments in River Transportation of Petroleum, by C. R. Horton, Jr., naval architect, Dravo Corporation, Pittsburgh, Pa.

Refining-Pressure Vessels

High-Pressure Vessels in Coal-Hydrogenation Service, by J. T. Donovan, mechanical engineer, Bureau of Mines, Louisiana, Mo., M. Josenhans, special engineer, Koppers Company, Inc., Louisiana, Mo., and J. A. Markovits, assistant chief, Bureau of Mines, Louisiana, Mo.

High-Pressure (10,300 Psi) Piping, Flanged Joints, Fittings, and Valves for Coal-Hydrogenation Service, by J. H. Sandaker, mechanical engineer, Bureau of Mines, Louisiana, Mo., K. B. Bredtschneider, special engineer, Koppers Company, Inc., Louisiana, Mo., and J. A. Markovits, assistant chief, Bureau of Mines, Louisiana, Mo.

6:00 p.m.

Fellowship Party

7:00 p.m.

Annual Banquet

Presiding Officer: William Raisch, consulting engineer, New York, N. Y.

Toastmaster: W. H. Carson, dean, College of Engineering, University of Oklahoma, Norman, Okla.

Address: James M. Todd, president, ASME

Speaker: Stewart Harrel, director of public relations, University of Oklahoma, Norman, Okla.

Subject: Oil and the Mechanical Engineer.

WEDNESDAY, OCT. 5

9:15 a.m.

Transportation

Sponsored jointly with Water Hammer Committee, ASME Hydraulic Division

Surge Problems in Pipe Lines, by S. Logan Kerr, consulting engineer, Philadelphia, Pa.

9:15 a.m.

Refinery Instrumentation

Control Valve—Its Application, by J. A. Pellettere, chief instrument engineer, Gulf Oil Company, Pittsburgh, Pa.

Instrumentation for Coal-Hydrogenation Service, by G. L. Bruno, project engineer, F. W. Geyer, senior engineer, Bechtel Corporation, and J. A. Markovits, assistant chief, Bureau of Mines, Louisiana, Mo.

Materials

Problems Associated With the Lining of Refinery Vessels With Corrosion-Resisting Materials, by G. C. Carpenter, corrosion engineer, Esso Standard Oil Company, Louisiana Division, Baton Rouge, La.

Application of Ni-Resist and Other Nickel-Containing Cast Iron to Pumps, Compressors, and Other Pieces of Petroleum Equipment, by Fred Sefing, metallurgist, International Nickel Company, New York, N. Y.

2:15 p.m.

Inspection Trip

Inspection of jet-engine repair facilities and test stands and aerial display of the P-80 Shooting Stars and a B-36 bomber at Tinker Air Field, as guests of U. S. Army Air Corps.

Refining Materials

Metallurgical and Fabrication Considerations in the Coal-Hydrogenation Demonstration-Plant Construction, by B. H. Leonard, Jr., mechanical engineer, G. D. Gardner, metallurgist, and J. A. Markovits, assistant chief, Bureau of Mines, Louisiana, Mo.

Design of Preheaters and Heat Exchangers for Coal-Hydrogenation Plants, by P. W. Laughrey and W. I. Gwillim, chemical engineers, Bureau of Mines, Louisiana, Mo., H. Schappert, special engineer, Koppers Company, Inc., Louisiana, Mo., and J. A. Markovits, assistant chief, Bureau of Mines, Louisiana, Mo.

ASME Sections

Coming Meetings

Southern California: Sept. 6. Hydraulic Division, California Institute of Technology, Pasadena. Subject: What Constitutes Good Piping Layout With Consideration for Fluid Flow, Physical Arrangement, and Specific Requirements of Connected Equipment. General Discussion.

Sept. 7. Hydraulic Division, California Institute of Technology, Pasadena. Subject: Pump Testing. Speaker: P. Brown.

Sept. 21. Hydraulic Division, California Institute of Technology, Pasadena. Subject: Construction Specifications. Speaker: A. Hunter.

Sept. 28. Hydraulic Division, California Institute of Technology, Pasadena. Subject: Selection and Design of Components for Hydraulic Systems. Speaker: J. A. Campbell.

Engineering Societies Personnel Service, Inc.

These items are from information furnished by the Engineering Societies Personnel Service, Inc., in co-operation with the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to all engineers, members or not, and is operated on a nonprofit basis. In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrant members whose availability notices appear in these columns. Apply by letter, addressed to the key number indicated, and mail to the New York office. When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available at a subscription of $3.50 per quarter or $12 per annum for members, $4.50 per quarter for nonmembers, payable in advance.

New York 8 West 40th St. | **Chicago** 84 East Randolph Street | **Detroit** 100 Farnsworth Ave. | **San Francisco** 57 Post Street

MEN AVAILABLE[1]

MECHANICAL ENGINEER, BME, North Carolina State College, 1943, some gas-turbine and Diesel-engine design experience, thorough foundation in mechanics. Desires position with opportunities for the future. Me-485.

MECHANICAL ENGINEER, BS degree, 1949, some drafting experience. Desires trainee or junior position in design or development with progressive firm. East or Midwest. Available immediately. Me-486.

REGISTERED PROFESSIONAL ENGINEER, mechanical, 30, married, experienced machine designer. BME, MME, Cornell. Capable of designing special-purpose machines, product design, plant layout. Machine-tool manufacturing background. Executive experience. West Coast. Me-487-475-D-8.

PLANT MANAGER OR PLANT ENGINEER, 48, PE license, nineteen years' management and reorganization; machine design and material testing, truck transportation, plant maintenance and construction, steam and electric power generation. Me-488.

MECHANICAL ENGINEER, college graduate, June, 1949, 27, married. Ambitious, industrious, start from bottom in heat transfer, refrigeration, turbines, power-plant equipment, design of small parts. Locate anywhere. Tau Beta Pi, Pi Tau Sigma Me-489.

MECHANICAL ENGINEER, BS degree, desires position in electromechanical design field. One year's experience translating electric circuit diagrams into shop manufacture and wire drawings. Location, immaterial. Me-490.

MECHANICAL ENGINEER, 29, BS. Recent graduate of University of Wyoming. Six years in Navy steam power plants and machine shops. Will go anywhere in United States. Me-491.

MECHANICAL ENGINEER, 25, single, Army veteran, master's degree, recent graduate. Desires position in power plant, industrial utilities preferred. Member Phi Kappa Phi. Excellent references. Experience desired. Me-492.

MECHANICAL ENGINEER, three and a half years' design, layout: tools, dies, automatic machinery. Knowledge production methods. Artistic ability. Desires product design, development, sales promotion. Prefers plastics. Me-493.

MECHANICAL ENGINEER, graduate, two years' experience with air conditioning and refrigeration contractor. Installations from three- and five-ton packages to forty-ton central. Estimate, design, survey, sales,

[1] All men listed hold some form of ASME membership.

service. Desires opportunity with U. S. or foreign concern. Me-494.

GENERAL WORKS OR PLANT MANAGER, 43, married, graduate ME and IE. Received Naval Ordnance Development Award, U.S.N., 1946. Over twenty years' engineering and manufacturing experience in light to heavy metal fabrication, precision electromechanical and electrical industry. Successful background of achievement in organization, planning, cost reduction, and labor relations. Heavy on manufacturing know-how. Tops in leadership and executive ability. Me-495.

MECHANICAL ENGINEER, 32, BME, experienced manufacturing layout, cost analysis, equipment engineering, product development, machine shop and maintenance. Desires engineering or supervisory position. Location, smaller cities: Lima, Peru, or similar locality. Me-496.

ENGINEERING MANAGER, Technical assistant to president, desires position with large concern. Proved expert on heat and power betterment. Me-497.

ENGINEER, 25, mechanical, Brown University, one year sales experience on industrial machinery; inquiries, specifications, quotations, office correspondence, familiar with New England-New York. Will travel or relocate. Me-498.

JUNIOR MECHANICAL ENGINEER, degree from Northwestern, September, 1949, plus four years' marine-engineering experience during war, plus mechanical aptitude, plus proved leadership ability equal A-1 production engineer. Me-499-M-119.

MECHANICAL ENGINEER, 28, graduated 1942, three years in industry including concentrated experience as area maintenance supervisor in complete charge of maintenance, construction, etc., of equipment in a large plant. Also, four years as Naval officer. Desires position as plant engineer or service (sales) engineer. Me-500.

GRADUATE MECHANICAL ENGINEER, 1949 22, married. Desires position as junior mechanical engineer. Willing to work in any section of country, preferably East. Me-501.

RECENT GRADUATE, BSME-Aero, 23, desires position preferably in aviation or allied field. Some experience in drafting and inspection equipment handling. Interested in sales, development, or design. Foreign or domestic. Me-502.

MECHANICAL AND INDUSTRIAL ENGINEER, 41, seventeen years' experience in engineering projects as plant engineer and master mechanic and superintendent in both industry and mining. Foreign experience in Latin America. Knowledge of Spanish. Knowledge of civil engineering and construction projects. Available in two months. Me-503.

MECHANICAL ENGINEER, 23, single, BME, MS, three years' diversified experience in laboratory-equipment design and plant maintenance. Desires position with future. New York City or vicinity. Me-504.

MECHANICAL AND DIESEL ENGINEER, BSME, 1941, MSDE (Diesel engineering) 1949. Interested in Diesel maintenance, power-plant design and installation. Arabic and Turkish languages. Other positions in U.S.A. or outside considered. Me-505.

MECHANICAL ENGINEER, BME, 1944, MME soon, 26, bright, good personality, with five years' diversified fundamental experience in design, drafting, process plant work, instruments; seeks employment in process-industries instrumentation and automatic control. Me-506.

MECHANICAL ENGINEER, recent graduate, young, married. Experience after school as optical sales representative, aero-laboratory assistant, scientific lecturer. Desires position with opportunity for advancement. Me-507.

MECHANICAL ENGINEER, January graduate, C.C.N.Y. BME. Half year's aircraft experience. Nine months on City College Rocket Research Project. Willing to travel or relocate. Prefers aircraft or machine-design fields. Me-508.

EXECUTIVE ENGINEER, 46, college graduate, ME, 1925. Last position, vice-president in charge of production; reorganized manufacturing procedure, engineering standards and development which tripled the dollar sales volume in 18 months of a company in the special and automatic-machinery manufacturing field. Prior to this as plant engineer supervised and carried out large plant-expansion program and during war acted also as technical consultant on special manufacturing problems. Experienced negotiator, organizer, and trouble shooter with ability to get things done. Specialist in the field of precision manufacturing. Me-509.

RECENT GRADUATE, 27, married, BME degree. Four years' experience as machinist in machine shop. Desires position with a future. Anywhere in the United States. Me-510.

ENGINEER, 34, registered PE, production and plant engineering, design chemical-process equipment tablet presses, welded-steel-plate construction, ceramic equipment. Desires position as assistant chief engineer, chief draftsman, or salesman. Philadelphia area. Me-511.

POSITIONS AVAILABLE

MAINTENANCE ENGINEER, 40, mechanical or chemical degree, with some experience in layout, design and installation of pumps, filter presses, and corrosion problems, for ore roasting and leaching plant. $5200. Northern New Jersey. Y-2605.

PLANT ENGINEER, mechanical graduate, with at least five to ten years' experience in general plant maintenance, power station, etc., preferably with textile company. Salary open. New England. Y-2612.

INDUSTRIAL ENGINEER, 35–45, mechanical, electrical, refrigeration, or industrial graduate, with several years' experience in detailed time study work in metal machining or fabrication, and experience in operating incentive wage plans, preferably piecework, both individual and group or similar plans such as standard-hour plan. Should have experience in most of the following: general machine shop, punch press, brake, welding, painting, assembly. Experience in union negotiations, including handling of union grievances. Knowledge of wage-rate administration, job evaluation, job classification, etc. Will supervise industrial engineering activities, time study and cost reduction, and wage-incentive plans. $9000. New Jersey. Y-2626-R-5814(a).

DESIGNER, mechanical graduate, to act as assistant to chief engineer, experienced with intricate precision machinery, Diesel experience preferred. Should be creative and mathematically sound. Knowledge of hydraulic controls. Will engage in design of fuel-injection pumps for a manufacturer. $7200. Illinois. Y-2644-R-5619.

ASSISTANT CHIEF ENGINEER, 30–40, with minimum of five years' experience, preferably in home-heating equipment. Any experience in air conditioning or refrigeration helpful. Must know design for production. $7000–$7500. Northern New Jersey. Y-2647.

DESIGN ENGINEER, 35–40, graduate, with a bachelor's degree and experience in machine design, preferably on equipment involving the forming and fabricating of metal parts or assemblies. Knowledge of welding procedure helpful. Company specializes in the manufacture and sale of flexible metallic hose and fittings. Will be responsible for the details of the solution of engineering problems, and the application of the results. Will institute and maintain contact with manufacturers and vendors of special equipment which might be used for the above purposes. $6600–$7200. Connecticut. Y-2673.

ENGINEERS. (*a*) Research engineer, 35–45, with at least five to ten years' experience in research design and development, preferably with business-machine background. $10,000. (*b*) Mechanical designers, 30–40, with considerable experience in the design of electromechanical machinery, particularly as applied to business machines. $7500–$8000. (*c*) Machine designers, 28–35, with three to five years' experience as above. Salary, to $6500. (*d*) Junior mechanical designer, with at least one or two years' experience, preferably with advanced degree, under 28, experienced as above. Salary, to $4500. Connecticut. Y-2680.

INDUSTRIAL ENGINEER, 35–45, with considerable experience on heavy-machinery operations, to do time study, methods, standards, etc., covering forgings and castings. Considerable traveling in Midwest. $6500 plus expenses. Headquarters, New York, N. Y. Y-2698.

MECHANICAL ENGINEER, 30–40, graduate, capable of taking charge of the operation and maintenance of the air-conditioning equipment in office buildings. Must have at least five years' experience in refrigeration and air-conditioning work, preferably on large equipment, experience in steam-power generation desirable. $5000–$6000. Northern New Jersey. Y-2704.

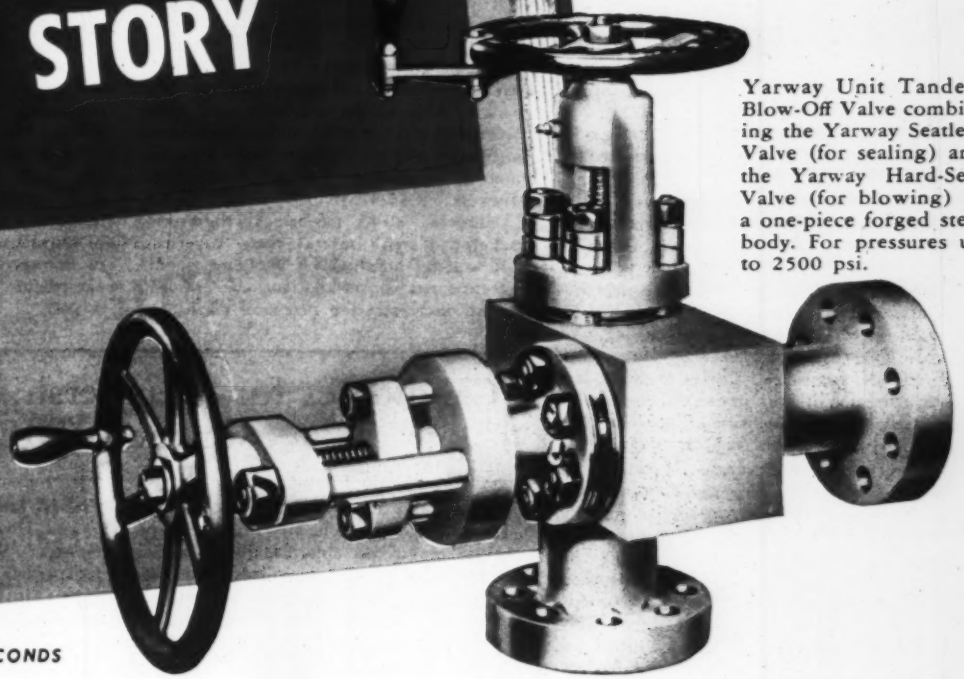
SMOKE-REGULATION ENGINEER, graduate in mechanical or chemical engineering, with broad experience in smoke control and related work. $5100–$5856. Virginia. Y-2710.

MECHANICAL ENGINEER, 38–45, with process-equipment experience, particularly refrigeration in food or beverage industry, to design and lay out installations. $6500. Northern New Jersey. Y-2716.

PRODUCTION-DEVELOPMENT ENGINEER, 35–45, mechanical graduate, with at least three years' experience as assistant to chief engineer.

(*ASME News continued on page 796*)

A HIGH PRESSURE STORY



Yarway Unit Tandem Blow-Off Valve combining the Yarway Seatless Valve (for sealing) and the Yarway Hard-Seat Valve (for blowing) in a one-piece forged steel body. For pressures up to 2500 psi.

READING TIME: 35 SECONDS

Not once-upon-a-time, but *today*, there is a certain valve that is giving such outstanding satisfaction in boiler blow-down service, that more than four out of every five high pressure boiler plants in the United States use it. That blow-off valve is the Yarway.

The reasons are threefold—excellent design, sound engineering, careful manufacture.

Yarway's famous Seatless Valves have no seat to score, wear, clog and leak. And Yarway Hard Seat Valves, especially suited for high pressure service, have special stellited seats and discs.

Second, constant research, leading to mechanical and metallurgical advancements keeps Yarway Valves ahead of changing service requirements.

Lastly, forty years of making blow-off valves, has taught Yarway how to make them right.

MORAL—For the best in blow-down service, buy Yarway blow-off valves. Completely described in Bulletin B-432. It's free. Write . . .

YARNALL-WARING COMPANY
108 Mermaid Avenue, Philadelphia 18, Pa.

YARWAY BLOW-OFF VALVES

Must have experience in fields of sheet-metal fabrication, metal-product design, hydraulics, tool design, etc. Must be able to inaugurate new designs, projects and procedures and have sufficient drive to carry them through to completion. Must be able to combine previous experience with the necessary research to meet novel situations in product and tool design, methods, administration, customer relations, procedures, etc. Will supervise engineering department of five employees. Willing to do board work when necessary. $6500–$7500. Illinois. R-5770.

DESIGNER, mechanical graduate, with ten years' experience with commercial precision product or machines. Knowledge of photo-engraving plate cutting equipment desirable. Information on cameras helpful. Will take over complete design from specifications through detail drawings for layout, manufacture, assembly, and shopwork for consulting engineering. $7500. Illinois. R-5777.

INDUSTRIAL ENGINEERS, mechanical graduates. (*a*) One thoroughly experienced in machine-shop practice and assembly operations. Cover complete engineering job—layout, materials, methods improvement, time study, and incentive application. (*b*) One experienced in production bookbindery making hard-cover books, involves methods improvements, materials handling, time study and installation of wage-incentive plan. (*c*) One with good experience in manufacturing of corsets and brassieres. Covers methods, layout, reduction of work in process, elimination of bottlenecks, and revision of incentive plan. Salaries open. Ohio. R-5781.

PHYSICIST OR MECHANICAL GRADUATE, advanced work desirable, 28–32, with three to five years' experience in special precision engineering, design of instruments, aeronautical equipment or other precision devices. Knowledge of Government contractural engineering methods as encountered in radar, rocket, atomic, or other special confidential fields desirable. Good school and industrial record, emphasis on research, development and design. Will work with contractors and designers contacting top technical and management personnel in observing, examining, and determining production capacity. Extensive U. S. traveling. $6000 and up. Headquarters, Illinois. R-5782.

ASSISTANT DIRECTOR OF ENGINEERING, 35–40, mechanical or civil graduate, twelve years' experience with food process engineering, design of civil, structural, electrical, and mechanical nature. Knowledge of industrial and construction processes and plant maintenance. Must possess organization ability. Will co-ordinate design of machines and equipment, designate materials, originate methods and improvements, maintain progress reports, give technical advice and assistance to staff and line departments. Contact and correspond with contractors, engineers, suppliers and management, work with confidential specifications construction, research, methods and design. Supervise ten employees. $7000–$8500. Minnesota. R-5783.

INDUSTRIAL ENGINEER, mechanical graduate, registered preferred, with experience in warehousing methods, equipment processes and management. Complete knowledge of time study, job evaluation, methods, standards, and terminology for warehousing. Informed about use of fork lifts, power manual and gravity conveyers, pallets, storage, and materials handling encountered in railroad and trucking companies. Will examine existing field operations, propose improvements and install revised methods and processing for an established management company. $6000–$6600, plus bonus. Traveling. Headquarters, Illinois. R-5790.

ASSISTANT TO PLANT MANAGER, 35–45, engineering graduate, ten years' experience with revisions, remodeling and expansion of plant, equipment and machinery. Knowledge of all operations including site selection, construction, layout and services, machinery and equipment (selection, installation, and operation), shop fabrication, production, methods, process and costs. Will act for plant manager in review, approval and supervision (run entire plant). Able to prepare, edit, and revise mechanical and construction drawings, advise on changes and improvements for a manufacturer of chemical fertilizers. Salary open. Midwest. R-5823.

DESIGNER, 30–40, mechanical engineering background, with several years' experience with special machinery involving speeds, gear-ratio mechanism and motion of medium weight, fast operating precision machinery. Will accept sketches, descriptions and specifications, and carry all engineering drawing and information through to completion for a company designing and building their own wrapping and carton machines. $4000–$6000. Illinois. R-5833.

PLANT ENGINEER, 35–45, mechanical graduate, with several years' experience, plus supervisory experience in mechanical and electrical maintenance, mechanical-handling equipment, machine repairs, construction and over-all plant preventive maintenance for a large manufacturer. Salary open. Illinois. R-5843.

PLANT ENGINEER, 30–40, mechanical graduate, with five to ten years' plant-engineering experience in paper or allied field. Knowledge of complete dock, railroad, and warehouse facilities and paper converting. Plant has annual capacity of 55,000 tons of paper and paperboard stock and complete paper converting facilities for production. $6000–$7200. Midwest. R-5844.

PUMP DESIGNER, civil or mechanical graduate, with five or more years' experience with centrifugal-pump design; knowledge of hydraulics, completely informed about design of impellers for company manufacturing line of sewage-treatment and water-purification equipment. Salary open. Chicago area. R-5847.

Candidates for Membership and Transfer in the ASME

THE application of each of the candidates listed below is to be voted on after Sept. 25, 1949, provided no objection thereto is made before that date, and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the secretary of The American Society of Mechanical Engineers immediately.

KEY TO ABBREVIATIONS

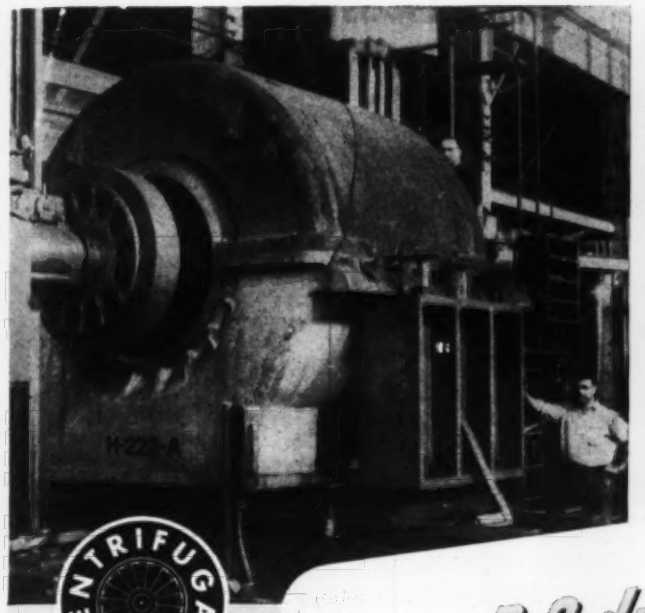
R = Re-election; Rt = Reinstatement; Rt & T = Reinstatement and Transfer to Member.

NEW APPLICATIONS

For Member, Associate, or Junior

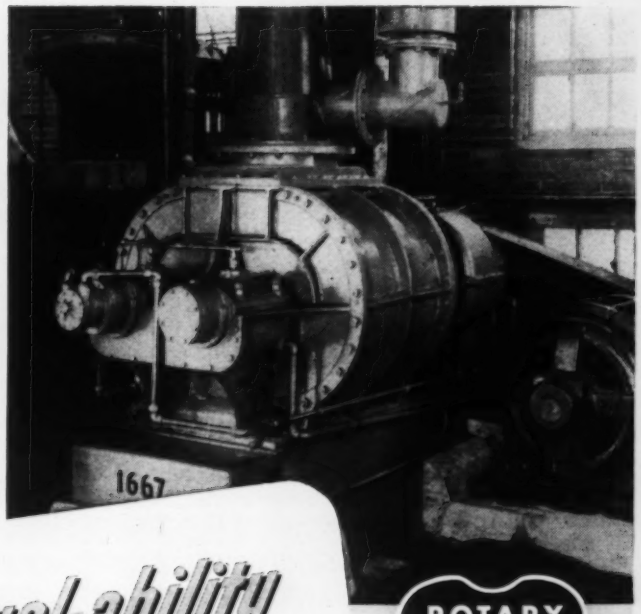
ALEVIZON, GEORGE V., Brooklyn, N. Y.
APKARIAN, HARRY, Watervliet, N. J.
BAKER, ELBERT E., Hamilton, Ohio
BERG, BERNHARDT C., Los Angeles, Calif.
BEULER, WILLIAM J., Oakfield, N. Y.
BEVAN, G. T., Schenectady, N. Y.
BLADE, EDWARD, Rugby, Warwickshire, England
BREGLIO, VINCENT STANLEY, Los Angeles, Calif.
BURKE, THEODORE E., Evanston, Ill.
BYLER, W. L., North Wales, Pa.
CHANDEHOK, F. S., Amritsar, India
COLLINS, WILLARD E., Chicago, Ill.
COLOMBO, WALTER, Castro Valley, Calif.
COWAN, RALPH T., Detroit, Mich.
CUMMIN, WILLARD MOTT, Newark, N. J.
DAVIS, C. R., JR., Columbia, Tenn.
FARRAR, PIERCE H., Ann Arbor, Mich.
FEAGIN, JEFFERSON B., Anniston, Ala.
FRANK, HOWARD A., Milwaukee, Wis.
GOERLICH, WILLIAM H., Lynbrook, L. I., N. Y.
GOLLENDER, MORTON, Forest Hills, N. Y.
HAMILTON, HANCE CARLYLE, Houghton, Mich.
HENKEL, ERICH, Calumet City, Ill.
HOBBS, KENNETH W., Panama City, Fla.
HORVATH, JOHN F., Milwaukee, Wis.
JESSER, B. M., New York, N. Y.
JORGENSEN, E. M., Phoenix, Ariz.
JUDSON, PROAL B., Aruba, Dutch West Indies
KEEFER, HOWARD D., Port Lavaca, Texas
KOCK, PAUL O., Cincinnati, Ohio
KRAMER, CHARLES E., Lafayette, Ind.
KRIEGEL, ROLAND M., Rockaway Beach, N. Y.
LAWNER, RUDOLF G., Long Island City, N. Y.
L'ECUYER, FERNAND, Montreal, Que., Can.
LOHMAN, J. T., Los Angeles, Calif.
MADIGAN, LAWRENCE M., New York, N. Y.
MALM, JOHN C., Los Angeles, Calif.
MIELISH, HERMAN, Arlington, N. J.
MORELLI, D., Pasadena, Calif.
MORRISON, EVERETT O., E. Orange, N. J.
MUENZER, H. E., Tacoma, Wash.
NAGELL, WALTER, Harvey, Ill.
PEACH, ROBERT W., Ann Arbor, Mich.
PETTUS, R. B., N. Hollywood, Calif.
POOLE, THOMAS W., Mexico, D. F., Mexico
RAMSDEN, C. D., Alameda, Calif.
RICHARDS, A. L., Montevideo, Uruguay, S. A.
RICHARDS, STEPHEN M., Liberty, Texas
SAMWAYS, JAMES, St. Louis Park, Minn.
SCHMIDT, THUR L., Chicago, Ill.
SCHRADER, HENRY A., Chicago, Ill.

(*ASME News continued on page 798*)



CENTRIFUGAL

R-C Centrifugal Blower, with capacity of 69,300 CFM, being built in our plant.



ROTARY

R-C Rotary Blower, type RCD, capacity 6,200 CFM.

LET *R-C dual-ability* SETTLE THE QUESTION

If you are in doubt about whether Centrifugal or Rotary Positive units will do the best job of handling gas or air on any specific application, you can obtain an unbiased answer from R-C *dual-ability*.

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FOR HANDLING GAS OR AIR, CALL ON *R-C dual-ability*

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Rotary Liquid and Vacuum Pumps

•

Positive Displacement Meters

•

Inert Gas Generators

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You can depend upon the value of R-C *dual-ability*, because handling air and gas has been our *exclusive* business for 95 years.

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★ ★ **ONE OF THE DRESSER INDUSTRIES** ★ ★